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26th Congress, 1st Session. Doc. No. 158. Ho. of Reps.

STEAMBOAT OWNERS—NEW YORK, AND LONG ISLAND SOUND.

MEMORIAL

OF

SUNDRY PROPRIETORS AND MANAGERS OF AMERICAN STEAMVESSELS,

ON

The impolicy and injustice of certain enactments contained in the law relating to steamboats, and asking to be restored to the rights and privileges which belong to other citizens engaged in navigation.

March 30, 1840.

Referred to the Committee on Commerce, and ordered to be printed.

To the honorable the Senate and House of Representatives of the United States of America in Congress assembled:

The memorial of the undersigned, proprietors, managers, and agents, of American steamvessels,

Respectfully showeth:

That, for several years, your memorialists have been actively engaged in steam navigation: and that, in thus employing a power which is universally known and acknowledged to be hazardous in its nature and use, they claim to have afforded and maintained a degree of security, in the transportation of persons and property, which has not been equalled by any other known means of transport or navigation. This important fact, so contrary to public apprehension, we trust will appear from the annexed documents, and also from any just and accurate comparison of the average losses and casualties by steam with the average losses and casualties which occur in other modes of navigation or transport.

For these results, which are on the whole so favorable, the public are not indebted to incentives furnished by pecuniary rewards; for your memorialists believe that no interests, involving such vast investments of capital, have generally been less productive. Nor is the present degree of security due to any interference of the Government with the mechanical arrangements and prudential management of our steamvessels, or to the enforcement of novel and severe principles of legislation; but has been owing to the inventive and discriminative powers, prudent foresight, and persevering spirit of those who are engaged in this important branch of national enterprise.

Blair & Rives, printers.

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This spirit of intelligent enterprise, producing results which have, generally, been more and more favorable to the security and advantage of the public, has continued in full activity to the present hour; with a firm reliance, on the part of those engaged, upon the guardianship and protection which is due from the Government of this vast country to an interest which is inseparably connected with its principal business relations and public resources, and which is destined to advance our country to the highest point of prosperity and power.

Your memorialists further represent, that certain enactments of peculiar novelty and severity, found in the act of Congress of July, 1838, are calculated to bear harshly and oppressively upon the owners of steamvessels, and thus to affect injuriously this important branch of our navigation. These enactments, instead of furnishing encouragement for a just and generous rivalry, in bringing steamvessels and their machinery to the highest possible state of security and perfection, have, unfortunately, in the view of your memorialists, a direct tendency to deter men of prudence, capacity, and property, from further connexion with this business; who are unwilling to submit to implied reproach and degradation, to unwarranted hazards, and to the loss of rights and privileges which are guarantied to all other persons engaged in a lawful calling. Your memorialists refer more especially to the clause which deprives them of the universal legal protection common to every civilized country, by unjustly construing, in the event of any serious disaster to life and property, the presumption of innocence into *prima facie* evidence of guilt: and they respectfully request of your honorable body that a provision which is so much at variance with their fundamental rights and privileges as American citizens may be repealed.

It is with painful regret that your memorialists have noticed an attempt to procure a broader and more mischievous application of this unjust principle, by means of proposed additions to this law; and they respectfully ask of Congress to be protected from such proposed aggravations of the already severe and relentless doctrines of the common law as it now governs the responsibilities of common carriers; and which, if enacted, must tend to destroy every just inducement for longer continuance in a business which is subjected to such unprecedented liabilities to loss and ruin. These extraordinary hazards and liabilities, it should be noticed, will not pertain to our competitors under a foreign flag; and our citizens may thus be virtually excluded from navigating the ocean by steam. Your memorialists would further remark that if, with the best knowledge possessed by this or any other country, this species of navigation be deemed too hazardous for the public safety, they deem it more just and honorable to submit to its entire prohibition.

Your memorialists believe that few opinions are more erroneous than that which ascribes to the provisions of the existing law a generally increased safety for persons and property carried in steamboats. This may appear from the many accidents or disasters of a serious character which have taken place during the short period in which this law has been in force. The number of these accidents on the western waters during the last year is stated to have been forty; which may serve to convince Congress that the appropriate remedies for these disasters are not furnished by this law; and can be found only in the increasing practical knowledge and skill of those persons who are engaged in the construction and management of steamvessels.

AVERY
DURST

Your memorialists do not seek to escape from any just responsibilities in conducting this important business. On the contrary, they feel bound to furnish every reasonable guarantee for safety to life and property which human foresight and prudence may be able to afford: and it is for the purpose of furnishing these guarantees in the most direct and practical manner, that they further respectfully but earnestly request, that Congress will call to the aid of its committees, to whose protection this important branch of navigation has been intrusted, the information and experience of some of the individuals whose lives have been devoted to its improvement and practice from its earliest origin in this country: in order that practical knowledge may form the basis of legislation upon a subject which affects more or less directly the interests and business of, probably, a great majority of the American people.

All which is respectfully submitted.

NEW YORK, *February* 22, 1840.

James A. Stevens
A. N. Hoffman
Robert Dunlop
Jonas C. Heartt
Richard P. Hart
Geo. B. Warren
D. Southwick
Alsop Weed
L. G. Cannon
R. D. Silliman
Wm. D. Haight
Nathan Dunchy
John Fame
G. S. Griffith
Peter Sharpe
Peter Van Alstym
John Hunter
John L. Thompson

For steamboats—North river line—Albany, De Witt Clinton, Swallow, Erie, Champlain, John Mason, Columbus, Union, General Jackson, Robert L. Stevens, and Jonas C. Heartt: about 5,500 tons; navigating about 250,000 miles annually.

Daniel Drew

For steamboats Rochester, Utica, and Saratoga

A. Vansantvoort
Wm. C. Redfield
Horace Stocking
Daniel Peck
Henry Greene
Asa B. Meech
Charles S. Olmstett
Pope Catlin
Marquis Barnes
J. Newton
James H. Hooker
G. S. Griffith
Jasper S. Keeler
Thaddeus Joy
Wm. Coughtry
Eliakim Ford, jr.
Thomas James
Henry Keeler

For steamboats Swiftsure, Constitution, Commerce, Illinois, Sandusky, Mount Pleasant, Oliver Ellsworth, United States, Henry Eckford, New London, James Fairlie, and John Jay, together with fifty-four freight steamvessels: being an aggregate of about 13,000 tons, and the several keels, navigating an aggregate distance of about 330,000 miles annually.

Thomas Powell
Samuel Johnson
Robert Wardrop

Proprietors of the steamboat Highlander, Newburg.

Benj. Carpenter
Charles Halstead
Wm. L. F. Warren

Proprietors of the steamboat James Madison, Newburg.

D. Crawford
Wm. K. Mailler
Joseph M. Brown
Gabriel P. Adams
C. Belknap, jr.

Proprietors of the steamboat Washington, of Newburg.

Jackson Oakley
Oliver Davis

Proprietors of the steamboat Superior, of Newburg.

Nevins, Townsend & Co.
Thaddeus Phelps
Charles Hoyt
James G. King
C. H. Russell
Wm. H. Russell
George W. Whistler
William Comstock
Charles A. Woolsey
Richard S. Williams
Thomas Williams, jr.
Seth Thay
Moses B. Ires
Joseph J. Comstock
Charles N. Talbot
George Curtis
R. & G. L. Schuyler
Robert Ray

For steamboats Massachusetts, Narraganset, Rhode Island, Providence, and Mohegan: aggregate tonnage 2,700; navigating about 120,000 miles annually; route by Long Island sound.

Daniel B. Allen

For steamboats Cleopatra, New Haven, and Flushing; 1,000 tons; Hartford, New Haven, and Sag Harbor lines; navigation about 70,000 miles annually.

James P. Allaire

For steamboat Osiris, from New York to Shrewsbury, New Jersey; navigating about 20,000 miles annually.

Lawrence & Sneden

For steamboats Telegraph, Croton, and Hope.

Curtis Peck

For steamboat Fairfield.

Charles Peck
Charles B. Peck, *Captain*.

For steamboat American Eagle.

Wm. W. Coit

For steamboat Norwich, navigating about 30,000 miles annually; Norwich and New London line.

O. Mauran

For steamers Hercules, Samson, Staten Islander, and Bolivar.

Gadsby's Hotel, *March* 27, 1840.

Dear Sir: I send you herewith a duplicate copy of our memorial on the steamboat law, with original signatures, for presentation in the House. As the supposed necessity of this legislation seems to rest on the state of public opinion, we have been at the pains (in appendixes A and B) to furnish such facts and considerations as will serve to correct the prevailing errors on this subject, and also (in appendix B) to correct the erroneous theories and practice in steam-navigation, particularly on our western waters. Sober appeals of this kind, from men in the profession, we believe, will do more to suppress disastrous accidents by steam, than all the restrictive laws and penalties that can be enacted.

For these and like reasons, our friends in New York earnestly desire the printing of 5,000 copies of the memorial and accompanying papers for general circulation, both with the public and with those connected with steam-navigation. This is the more desirable, because it will be the *first time* that the representatives of this important interest have been heard on the question.

It is proper to state, however, that a part of appendix B was printed at the commencement of the last session, by order of the House, as an appendix to document 21. But this having been done *after the document was circulated*, the object was not attained, except in a very few instances. There are also corrections and considerable additions of *new matter* in that part of the paper which is now presented as appendix B; and it is to this latter appendix that you will consider these last remarks to apply; appendix A having not been printed except by ourselves for our memorial. The Senate, I understand, have printed only the usual number of copies.

We also respectfully and especially request that, when the bill from the Senate shall have reached your House, the committee to which it may be referred will cause us to be sent for and heard before them on its merits, and, to that end, that it may be printed as it shall come from the Senate.

Yours, with great respect,

WM. C. REDFIELD,
In behalf of the memorialists.

Hon. EDWARD CURTIS,
House of Representatives.

APPENDIX A.

No. 1.

The following communication was made by request to the commissioners appointed by the English Government for conducting an inquiry into the causes of steamboat accidents and the practical means of preventing their recurrence.

NEW YORK, *June* 12, 1830.

SIR: Having received, through a valued friend, a copy of the circular issued by the Lords Commissioners of the Board of Trade, which authorizes an inquiry, through the agency of yourself and Mr. Parke, "into the nature and causes of the accidents which have occurred in steamvessels, and whether any measures can be taken in order to prevent the recurrence of such accidents," accompanied also by a request for my views on this subject, I will cheerfully respond to the inquiry in such manner as is suggested by my own experience and observation.*

The accidents comprised in this inquiry may be classed under the following heads:

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* This communication did not reach England till after the publication by Parliament of the report made to the Government by Captain Pringle and Mr. Parke.

I. Accidents by shipwreck.
II. Accidents by collision.
III. Accidents by fire.
IV. Accidents by explosions, or by the injurious escape of steam.

The following suggestions on these several topics are offered for your consideration:

I. The liability of steamvessels to shipwreck or loss at sea by stress of weather may chiefly depend on the following causes or considerations:

1. The ability to avoid being stranded or cast on a lee-shore, as in the case of the Rothsay Castle, the Killarney, and the Forfarshire, steamvessels, must depend mainly upon the power which can be commanded for encountering successfully the winds, tides, and seas, and for keeping the vessel manageable or under the control of the pilot or navigator.

This power must depend, 1st. On the general rate and efficiency of the engine; 2d. On the ratio of velocity, or, in common sea-language, *purchase*, between the piston and the paddles;* 3d. On the strength of the boiler, and its security from inundation; the boiler, if near the bottom of the vessel, being liable to have its fires extinguished by any accidental accession of water in the hold.

2. The liability of the hull of a steamvessel to receive injury from stress of weather, when clear of the land, as in the cases of the English steamer Royal Tar, in the Bay of Biscay, and the American steamboat Home, on the coast of North Carolina, appears to depend greatly on the mode of construction which may have been adopted. Steamers require a greater proportionate length than is given to other vessels; and being oftener kept up to the wind and sea, they are more liable than other vessels to suffer from straining. The best remedy which is suggested for this evil consists in a change in the system of naval construction. In the present system reliance is mainly had upon spikes, bolts, or treenails, driven traversely, and aided also, in some cases, by longitudinal bolts, bedded in the vessel's frame; but no effectual measures have been taken to transfer the laboring strain, which falls laterally upon the fastenings and their bearings, to the timbers and planking, or the mass of woody fibre. Hence, when a heavy stress is thrown upon the fastenings, their bearing-surfaces in the wood are found to yield, and even the fastenings themselves become subject to flexure. Thus the planks are moved, the seams are loosened, and water is admitted, to the immediate hazard and damage of the vessel, and causing also a premature decay.

I propose, as a remedy for this evil, that the frames of the vessel (if closely built) be so moulded as to project, alternately, inward and outward, to the extent of say three-fourths of an inch beyond the general surface, so as to form alternate projections and depressions on both the interior and exterior surfaces of the framing. Each plank should be of somewhat more than the usual thickness, and is first to be fitted to its place, and its bearing-surface then cut out in such manner as to receive the projections of the framing in the closest manner; the several butts being scarfed, so as to lock the continuous planks together by means of one of the projecting frames. After laying three or four planks in this manner, the next one is to preserve its full thickness throughout, and is to be let into an opening

* The advantages of an increased ratio of velocity in the piston are far more important in stress of weather than in the ordinary circumstances of navigation.

which is nicely cut to the depth of the projections of the frame, so as to interlock against the lateral or calking strain, to which the planks and timbers are exposed; and these modifications of the interlocking process are to be repeated throughout the planking, except, perhaps, in some parts near the extremities of the vessel where the strain is less, and the greater bending of the planks may render the overlocking part of the process too inconvenient.

On this plan the strain upon the fastenings is chiefly longitudinal, and they perform little other duty than that of holding the several parts of the structure in close contact; while the great strain, which results from the weight and throw of the vessel and her cargo by the power of the sea, is brought to bear upon the general mass of woody fibre which is used in construction, and which is competent to sustain it without the least injury; while, in the usual system of construction, perhaps more than two-thirds of the wood employed is quite unavailable for the support of the vessel against heavy straining at sea, and contributes also, by its weight, to the strain upon the fastenings.*

II. Accidents from collision.—These, it is believed, are mostly owing to the want of a simple and well-digested system of regulations for the government of vessels which are steering in opposite directions, especially in the night-season or in thick weather. Various plans have been recommended in Europe and America, but I know of none that I think equal to the system established on the waters of the State of New York; where, with perhaps the most active night-navigation in the world, accidents by collision have now become quite rare.

It is important for each pilot or navigator of a steamvessel to be able to understand the course or courses which are steered, and will continue to be taken, by the vessels which he may meet. For this knowledge we must chiefly rely upon a judicious system of lights, and upon the reasonable presumption that no steamvessel will vary from its usual and proper course without good cause.

Owing to their sharpness and great length, steamvessels are not adapted to turning and dodging in their course; for any such practice is highly dangerous and should never be attempted. If a slight variation of the course be judged insufficient for avoiding collision, the proper alternative is to stop instantly, and work the engine aback.

In this quarter, when steamers are likely to *meet* each other on opposite courses, each keeps sufficiently to the right to avoid collision, as required by law; but this rule does not require the steersman to change from one side of an approaching vessel to the other, for this would not unfrequently end in confusion and accident. In the night-time, the course of other steamers is ascertained by means of the two signal-lights, at the bow and stern, which each steamvessel carries.

The forward lights are placed outside the bow, on each side of the stem, and enclosed, except in front, so as not to interfere with the view of the pilot or steersman; while the stern lights are hoisted upon the flagstaff at the taffrail, some forty or fifty feet above the deck. The comparative *distance* of these or other lights cannot always be well determined; but the *low* light is known to be at the bow, and the *high* light at the stern, and,

* In this plan of construction it is not intended to dispense with the auxiliary aid of a system of diagonal braces and riders, which should also be interlocked with the vessel's side; but diagonals will be of little benefit if secured only by the common lateral fastenings.

according to the angle or distance at which the low light is subtended to the right or left of the high one, is the course of the approaching steamer, with entire certainty, determined; and the probable changes to be expected in her course, if any, are known by her position in the channel-way and her probable destination. Thus, nearly all sources of uncertainty and confusion are avoided, by means which are at once both simple and effectual.

I have seen it recommended to place lights of different colors on the paddle-covers; but this can only serve to distinguish steamers amid a multitude of other lights, and in a very crowded navigation. Nor should lights ever be carried in such a position as, by their glare or reflection, will embarrass the night view of the steersman; and by exposing as few lights as possible, a great source of confusion is avoided. I also hold it as essential, that a steamvessel should be steered from the highest portion of her central or forward body, by means of a wheel and tiller-ropes; and that, in narrow waters or a crowded channel, the *cun* of the vessel should be assumed only by an officer or pilot standing at the wheel, who *feels* the helm, while he has also the advantage of an unobstructed view.

You will find annexed a copy of the principal sections of the steamboat law of the State of New York.* This statute is not recommended on account of its penal enactments, which, being probably designed to allay popular apprehensions, have been chiefly fortuitous, and are, mainly, inoperative; but as exhibiting our practical system for the avoidance of collisions, which has, very properly, found place among its provisions.

III. Accidents by Fire.—This being a subject to which the common observation and attention of mankind are largely directed, it appears hardly necessary to discuss it on the present occasion. In addition to other securities, good forcing-pumps with air-chambers and hose, having the essential qualities of a fire-engine, should always be provided, both near the boilers and furnaces and in situations above deck, which will be always accessible, in case of being driven from the former by accidents of fire or steam.

IV. Accidents by Explosion, or injurious escape of Steam.—This is doubtless the chief topic which claims our consideration on the present occasion.

As regards the means which are now chiefly relied on as affording security from steam explosions—such as careful and intelligent management, the providing of good safety-valves, gauge-taps, glass water-gauges, pressure-thermometers, mercurial pressure-gauges, and the like—I am not aware that any thing new and useful can now be offered; and am convinced, that if due attention to these could have ensured entire safety, it would have been already attained. But an attentive consideration of the various accidents which have occurred within the circle of my observation, and of those also which have come to my knowledge through the publications of the day, has led me to the following conclusions: *First*, That accidents, more or less serious, must be expected sometimes to attend the use of the steam-engine, as well as all other efforts or combinations of human skill, and that the interests and safety of the public are not best promoted by resorting to a system of onerous and penal legislation in regulating its use. *Second*, That a very great proportion of the steam-

* This law may be found in the Revised Statutes of New York.

accidents which have occurred on both sides of the Atlantic have been owing chiefly to defects in the general system of construction, and not, as has been very generally supposed, to the want of cautionary apparatus, or the gross neglect of those who were intrusted with the executive duties.

The last conclusion, though at variance with opinions which are extensively entertained, may also be sustained by a careful examination of the degree of strength which is afforded by the weakest portions of common steam-boilers, as compared with the maximum pressure and incidental hazards to which they are liable. This want of a sufficient disparity between the maximum of force and the minimum of resistance, will appear still more obvious by extending the comparison to other structures or effective laboring machines of like metal, where, in all important cases, it is believed, a much greater proportionate strength is usually found than pertains to steam-boilers of the ordinary construction.

But however this may be, it appears certain that in this quarter the accidents to steam-boilers have been nearly in proportion to their deficiency in comparative strength. This point deserves, however, a more complete elucidation than can be attempted at this time, and I therefore refer to a communication to the honorable Secretary of the Treasury of the United States, on the general subject, which I prepared a few months since in compliance with a resolution of inquiry which was passed by Congress.*

It is obvious that there are few uses to which metals are applied which demand so much attention to strength and security, as in the manufacture of steam-boilers. These should be so constructed as to be guarded, on this point, against all contingencies of the use which are likely to occur.

If an examination of the English and American steamvessels should show a degree of deficiency on this point, the cause may be readily found in the influence of habit, of prevailing opinions, and of previous examples, which have had their origin in an early stage of the art; and also in considerations of practical convenience and facility of manufacture. That the warnings resulting from the various disasters which have occurred have failed to some extent in their preventive effects, is probably because the theoretical opinion has been honestly and sedulously cherished, that these accidents have occurred only through the culpable carelessness and neglect of those in immediate charge of the boilers; and the evil is thus in some degree rendered permanent.

That the safety of steam-boilers from explosions does not necessarily depend upon working with so low a pressure as five or seven pounds to the square inch, and that a reasonable increase in the proportionate strength of the boilers in steamvessels would remove all immediate hazard, and nearly end the catalogue of these disasters, is rendered apparent by the facts which relate to this branch of navigation as it has been carried on in various directions from the city and port of New York. Here, where steam-navigation was first successfully established, and where it has probably attained its highest degree of efficiency, we might have expected that accidents and disasters would, not unfrequently, attend the use of a power at once so novel and energetic. The accidents and fatalities which have here occurred, as well as their probable proportion to the pressure of steam, the number of boats employed or trips made, the number of miles navigated, and the number of passengers which from time to time have been exposed, may be seen in the annexed table.

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* For a revised copy of this communication, see appendix B.

A tabular estimate of the amount of steam-navigation connected with the port of New York, the number of passsengers carried, and the steam accidents, together with the average and comparative hazards which have attended the same, for three successive periods of five years each, beginning with 1824 *and ending with* 1838.

Routes from New York.	First period, from 1824 to 1828, both inclusive.										
	Length of route in miles.	Probable number of passages or trips per year.	Probable number of passengers and crew exposed on each trip.	Estimated number of passages or trips made in the five years.	Aggreg'e miles navigated in the five years.	Estimated number of persons exposed in the several passages during the five years.	Number of accidents.	Number of lives lost.	Ratio of accidents to the whole number of trips.	Ratio of loss to the whole number of exposures.	Estimated average pressure of steam used in 1825.
To Albany and Troy	150	1,850	120	9,250	1,387,500	1,110,000	1 *a*	3	1-9,250	1-370,000	7 lbs. to the square inch.
To Hudson and Catskill	120										
To Kingston and Rhinebeck	90										
To Poughkeepsie	75										
To Newburg, Fishkill, &c.	60	320	80	1,600	96,000	128,000					
To Peekskill and Sing Sing	40	320	60	1,600	64,000	96,000	1 *b*	1	1-1,600	1-96,000	
To Haverstraw and Tappan	35										
To Fort Lee	8										
To Jersey City and Hoboken	1¼	16,600	12	83,000	103,750	996,000	1 *c*	2	1-83,000	1-498,000	
To Elizabeth'n, Amboy, & N. Brunsw'k	40	1,120	80	5,600	224,000	448,000	3 *d*	20	1-1,866	1-22,400	
To Staten island	6	1,120	40	5,600	33,600	224,000					
To Newark	22										
To Middletown point, &c.	18										
To Shrewsbury, Rockaway, &c.	22	120	40	600	13,200	24,000					
To Brooklyn and Williamsburg	½	25,000	10	125,000	62,500	1,250,000					
To Charleston, S. C.	700										
To Flushing bay, &c.	12	700	30	3,500	42,000	105,000					
To New Rochelle, &c.	20										
To Sawpits, Norwalk, and Bridgeport	55	480	60	2,400	132,000	144,000					
To New Haven	74	360	40	1,800	133,200	72,000	1 *e*		1-1,800		
To Connecticut river	160	210	60	1,050	168,000	63,000	1 *f*	3	1-1,050	1-21,000	
To New London and Norwich	135	160	50	800	108,000	40,000					
To Stonington	135										
To Rhode Island	200	240	60	1,200	240,000	72,000					
Unlocated boats (say)*	25	160	30	800	20,000	21,000	4 *g*	9	1-200	1-2,666	
Totals and average results	–	48,760	–	243,800	2,827,750	3,796,000	12	38	1-20,317	1-126,211	7 lbs.

* The miscellaneous business is doubtless greatly underrated.

a Constitution. *b* Franklin. *c* Jersey. *d* Etna (high pressure), Bellona, Legislator. *e* Hudson. *f* Oliver Ellsworth. *g* Fidelity, Patent, Caroline, ——.

Average number of miles navigated to each explosion, 235,646.

ESTIMATE—Continued.

Routes from New York.	Second period, from 1829 to 1833, both inclusive.									
	Length of route in miles.	Probable number of passages or trips per year.	Probable number of passengers and crew exposed on each trip.	Estimated number of passages or trips made in the five years.	Aggregate miles navigated in the five years.	Estimated number of persons exposed in the several passages during the five years.	Number of accidents.	Number of lives lost.	Ratio of accidents to the whole number of trips.	Ratio of loss to the whole number of exposures.	Average pressure of steam in this period.
To Albany and Troy	150	2,291	150	11,470	1,720,500	1,720,500	2 *h*	18	1-5,735	1-95,583	11 lbs. to the square inch.
To Hudson and Catskill	120	160	80	800	96,000	64,000					
To Kingston and Rhinebeck	90	160	40	800	72,000	32,000					
To Poughkeepsie	75	160	40	800	60,000	32,000					
To Newburg, Fishkill, &c.	60	400	80	2,000	120,000	160,000					
To Peekskill and Sing Sing	40	500	70	2,500	100,000	175,000	1 *i*	15	1-2,500	1-11,666	
To Haverstraw and Tappan	35	240	40	1,200	42,000	48,000					
To Fort Lee	8										
To Jersey City and Hoboken	1¼	30,000	14	150,000	187,500	2,100,000					
To Elizabethtn, Amboy, & N. Brunsw'k	40	1,600	100	8,000	320,000	800,000					
To Staten island	6	1,600	45	8,000	48,000	360,000					
To Newark	22	1,120	60	5,600	123,200	336,000					
To Middletown point, &c.	18	120	40	600	10,800	24,000					
To Shrewsbury, Rockaway, &c.	22	120	40	600	13,200	24,000					
To Brooklyn and Williamsburg	½	45,000	12	225,000	112,500	2,700,000					
To Charleston, S. C.	700	24	60	120	84,000	7,200					
To Flushing bay, &c.	12	800	35	4,000	48,000	110,000					
To New Rochelle, &c.	20										
To Sawpits, Norwalk, and Bridgeport	55	600	80	3,000	165,000	240,000					
To New Haven	74	500	50	2,500	185,000	125,000	1 *j*	9	1-2,500	1-13,888	
To Connecticut river	160	360	80	1,800	288,000	144,000	1 *k*	20	1-1,800	1-7,200	
To New London and Norwich	135	160	60	800	108,000	48,000					
To Stonington	135										
To Rhode Island	200	300	80	1,500	300,000	120,000					
Unlocated boats (say)	25	100	40	500	12,500	20,000					
Totals and average results	–	86,318	–	431,590	4,216,200	9,419,700	5	62	1-86,318	1-151,931	14 lbs.

h Ch. J. Marshall, Ohio. *i* General Jackson. *j* United States. *k* New England. Average number of miles navigated to each explosion, 843,240.

ESTIMATE—Continued.

Routes from New York.	Third period, from 1834 to 1838, both inclusive.										
	Length of route in miles.	Probable number of passages or trips per year.	Probable number of passengers and crew exposed on each trip.	Estimated number of passages or trips made in the five years.	Aggregate miles navigated in the five years.	Estimated number of persons exposed in the several passages during the five years.	Number of accidents.	Number of lives lost.	Ratio of accidents to the whole number of trips.	Ratio of loss to the whole number of exposures.	Average pressure of steam in 1839.
To Albany and Troy	150	2,738	200	13,690	2,053,500	2,738,000	1 *l*	2	1-13,690	1 1,369,000	18 lbs. to the square inch.
To Hudson and Catskill	120	240	100	1,200	144,000	120,000					
To Kingston and Rhinebeck	90	320	60	1,600	144,000	96,000					
To Poughkeepsie	75	160	80	800	60,000	64,000					
To Newburg, Fishkill, &c.	60	480	80	2,400	144,000	192,000					
To Peekskill and Sing Sing	40	660	80	3,300	132,000	264,000					
To Haverstraw and Tappan	35	240	60	1,200	42,000	72,000					
To Fort Lee	8	800	40	4,000	32,000	160,000					
To Jersey City and Hoboken	1¼	40,000	16	200,000	250,000	3,200,000					
To Elizabetht'n, Amboy, & N. Brunsw'k	40	1,800	130	9,000	360,000	1,170,000					
To Staten island	6	2,240	50	11,200	67,200	560,000					
To Newark	22	1,120	80	5,600	123,200	448,000					
To Middletown point, &c.	18	160	50	800	14,400	40,000					
To Shrewsbury, Rockaway, &c.	22	160	50	800	17,600	40,000					
To Brooklyn and Williamsburg	⅜	72,000	15	360,000	180,000	5,400,000					
To Charleston, S. C.	700	48	80	240	168,000	19,200	1 *m*	6	1-240	1-3,200	
To Flushing bay, &c.	12	800	40	4,000	48,000	160,000					
To New Rochelle, &c.	20	360	50	1,800	36,000	90,000					
To Sawpits, Norwalk, and Bridgeport	55	500	100	2,500	137,500	250,000					
To New Haven	74	600	60	3,000	222,000	180,000					
To Connecticut river	160	450	100	2,250	360,000	225,000					
To New London and Norwich	135	220	70	1,100	118,500	77,000					
To Stonington	135	1 yr. 480	70	480	64,800	33,600					
To Rhode Island	200	500	100	2,500	500,000	250,000					
Unlocated boats (say)	25	150	50	750	18,750	37,500					
Totals and average results	–	127,226	–	634,210	5,467,450	15,886,300	2	8	1-317,105	1-1,985,787	18 lbs.

l Novelty (high pressure), 1837. *m* William Gibbons, January, 1836. Average number of miles navigated to each explosion, 2,733,725.

[N. B. Accidents other than by steam were not included in the above table; only one of a fatal character being recollected, which happened at sea. The calamitous loss of the Lexington, at a more recent period, will doubtless inspire additional caution in all future navigation. In reference to the comparative and increasing safety of steam-navigation, which may be deduced from the above table, it is proper to notice, that a large portion of the above consists of a regular and unremitted *night-navigation*, which is carried on in every variety of weather.]

This table, so far as relates to the service performed on the different routes and the number of persons exposed, is made up approximately, by estimates founded on my general acquaintance with our steam navigation; but is believed to be sufficiently correct for general purposes. I have separated the business of the fifteen years which it comprises into three several periods of five years each, commencing with 1824; early in which year the navigation, in this State, which had previously been controlled by the associates of Fulton and Livingston, was thrown open to all competitors.

It appears from the average results of this table, that during even the first period of five years after the navigation was thrown open to public competition, the ratio of steam accidents was only equal to one for more than 20,000 trips or passages; and that the average loss of life was only equal to one for more than 126,000 passengers exposed. Thus, at the fair outset of this noble enterprise, a degree of safety was attained for the passenger, such as may well challenge comparison with any artificial means of transit or locomotion that has ever been resorted to by the human race.

It appears, further, on comparing the results of these several periods, that the ratio of steam accidents for the first and third periods, as compared with the probable number of trips made, has decreased from one in 20,317, for the first period, to one in 317,105, for the third or latest period; showing a diminution of the ratio of accidents, in the average period of ten years, equal to *about* 84 *per cent.* The ratio of lives lost from these accidents during the same period has also decreased from one in 126,211 to one in 1,985,787; equal also to a diminution in the ratio of personal hazard, in this short period, *of* 84 *per cent.*

It appears also from this table, that during the first of these periods the average number of miles navigated by all our steamboats to each explosion which occurred, was equal to 235,646—a distance equal to many times the circumference of our globe, and about equal to that from the earth to the moon. But even this ratio has been rendered tenfold more favorable in the short average period of ten years, being for the latest five years 2,733,725 miles navigated for each explosion; or more than eleven times the distance from the earth to the moon; and reducing the ratio of hazards in proportion to distance, *almost* 90 *per cent.**

This remarkable diminution of accidents and hazard, it may be seen, has taken place in the very period in which the average working pressure of steam has been more than doubled. It has also been attained solely by professional skill and experience, and without any aid from legislative in-

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[* The results of a like examination extended to the whole Atlantic tide-waters, and the great lakes, it is believed, would be no less favorable. But it will doubtless be supposed, that on our western rivers the ratio of accidents and hazard by steam explosions must have been far greater. This is probably true, in a degree, owing to the ultra and improvident system of high pressure construction which there prevails. But let the inquiry be strictly made, upon the above principles of analysis, and it may serve to show how uncertain a test of the real hazard is found in public prejudice, or individual apprehension. The constructors and managers of western engines and steamboats owe it to themselves, to their profession, and the public, to make this inquiry; so that the faults, or the safety, of their favorite system of engineering may fully appear. If a scheme of penal enactments shall there be found necessary and available for the protection of human life, which I cannot readily believe, let it be confined to those waters which are above the flow of the tide; or, which I deem better and more efficient practice, let their present system be either modified or discontinued.]

terference; for the law of Congress on this subject was not in force till near the close of the year 1838. Had such a system of legislation been at first adopted, there are sound reasons for concluding that it would not have prevented disasters, but might have greatly retarded the rapid advance in safety, as well as improvement, which has been so happily attained.*

It must not be supposed, however, that the average pressure of steam now used on the New York steamboats can be greatly increased, without incurring material hazard. The thickness which is found most suitable for boiler-metal, and the practical and economical limits of form and size, are such as should prevent us from allowing a maximum pressure exceeding one and a half or two atmospheres above the common boiling point, for condensing engines; with an addition of about one atmosphere for high-pressure engines, which are worked without a condenser and air-pump. To these limits, *if an adequate system of boiler construction be adopted*, the pressure may with safety be carried, as is done in locomotive engines, in the use of which, owing to a better system of construction, fatal accidents have been less frequent, perhaps, than with low-pressure marine engines.

I annex, also, a copy of the law of the United States, entitled "An act to provide for the better security of the lives of passengers on board of vessels propelled in whole or in part by steam."

It may be proper to remark, that the passage of this law was unexpected to the owners of steamvessels, and that it appears to have been considered by Congress itself as a premature measure, as may be inferred from the resolutions for instituting an inquiry on this subject, which were passed at the same period.

More recently, a bill has been reported to the Senate of the United States, near the close of the last session, designed as a substitute for the existing law.

This bill, it will be perceived, imbodies nearly all the precautionary measures which have been suggested in various quarters for preventing steamboat accidents, and, for enforcing these prescriptive measures, an onerous and complex system of penalties is provided in the bill; the owners, managers, and officers of steamboats being apparently viewed, as in the present law, as a class having feelings and interests which are

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[* January, 1840. On the 13th of the present month the steamboat Lexington took fire on Long Island sound, and was destroyed. By this frightful disaster 124 lives were lost, and only four persons escaped. The loss of this vessel was perhaps owing to the combustible nature of the materials in which the fire broke out, the want of immediate and concerted action to arrest its fatal progress, and the panic which appears to have prevailed on board. To these circumstances, and especially to the latter, is ascribed the extraordinary destruction of life, all the boats having been lowered and lost while the engine was running at full speed.

The loss of a large amount of property by the owners and managers of the Lexington, and the destruction of thirty-nine valuable lives of persons in their service, might have shown that no reasonable motive or provision was likely to have been wanting to secure safety for all on board, whatever may have been the momentary errors or indiscretions of the crew or passengers. Those who have labored to inflame the public against these unfortunate men may well be reminded, that it is now thirty years since the public have enjoyed the use of passenger-vessels impelled by fire and steam, and that during this period not less than *thirty millions of persons* have been transported from time to time in the various steamboats which have run to and from the city of New York, and that these steamboats have probably navigated a distance equal to *fifteen millions of miles*, and that in all this prolonged and varied exposure, *never before has a single life been lost by the burning of a steamboat.* This fact alone, to the unprejudiced, speaks volumes in favor of the general care and skill of the parties who have been concerned in this species of navigation.]

adverse to the safety and welfare of the community. Of the great error of this newly-assumed principle in legislation, or of the practical value of such a system of enactments, it is not my purpose further to inquire; these being questions which relate solely to American legislation. Nor is the slightest disrespect intended to the views of the honorable and highly intelligent Senator who reported this bill; who doubtless considered it to be his duty thus to prepare, for more mature consideration, the various projects for securing safety which had been urged upon his attention.

I have long been convinced, however, that governments should not attempt to become responsible for the prevention of accidents to the boilers or machinery of steamvessels, any more than for the errors and failures of any other machines or fabrics; and that the remedies for these accidents must be sought elsewhere than in legislative enactments, which should relate only to matters which may partake of the character of conventional regulations, for the general convenience and safety of navigation. The most available and useful legislative provision for these accidents, I conceive to be that which shall provide, in every case of explosion or injury bysteam, for a thorough investigation of all the facts and circumstances which may tend to throw any degree of light upon either the immediate or the remote causes of the disaster; and this inquiry, I think, should be instituted solely for public benefit in the promotion of correct knowledge, and be conducted at public expense.

With my best wishes for the success of the important inquiry in which you are engaged, I subscribe myself, dear sir, your most obedient servant,

WM. C. REDFIELD.

Captain J. W. PRINGLE, *R. E.*

No. 2.

ACCIDENTS TO BRITISH STEAMVESSELS.

The following schedule of accidents to British steamvessels is extracted from the report on steamvessel accidents, made by Captain Pringle, R. E., and Mr. Josiah Parkes, C. E., and ordered to be printed by the House of Commons, May 31, 183?.

SCHEDULE OF ACCIDENTS.

No.	Year.	Name of vessel.	Where employed.	Nature of accident.
1	1817	Norwich	Norwich and Yarmouth	Explosion of boiler; 9 killed, many wounded.
2	1817	Prince Regent	Thames	Fire; burnt to a wreck off Reculver, by taking fire round the chimney.
3	1820	Robert Bruce	Clyde	Fire; burnt to a wreck off Anglesea.
4	1824	Eagle	Hull and Gainesbro'	Explosion while steaming; 1 killed.
5	1824	Duke of Bridgewater	Runcorn and Liverpool	Explosion; 2 persons killed, many injured and thrown into the water.
6	1825	James Ewing	Clyde	Explosion of boiler-flues at Plaisley Water.
7	1825	City of Glascow	Glascow to Liverpool	Wrecked at the Isle of Man; all came near perish'g.
8	1825	Comet and Ayr	Clyde	Collision; 62 persons drowned or killed.
9	1826	George IV.	Southampton	Fire; burnt nearly to water's edge.
10	1826	Graham	Grimsby and Hull	Explosion of boiler; 6 killed, many injured.
11	1827	Fingal	Glascow	Explosion of boiler; 2 lives lost.
12	1827	Town of Liverpool	Liverpool	Wrecked on Waterford rocks.
13	1828	Sheffield	Liverpool	Wrecked on Sculmartin Rock; went to pieces.
14	1828	Corsair	Belfast and Liverpool	Explosion of boiler; 1 killed.
15	1828	Columbine	London and Bologne	Wrecked; crew and passengers saved by French fishermen.

16	1828	Clydesdale	Glasgow	Fire; burnt to a wreck near Crestwell light-house.
17	1828	Magdalene	Dundalk	Explosion of boiler; 40 hogs scalded.
18	1829	Manchester	Liverpool	Foundered; coming from Dublin to Liverpool.
19	1829	Venus	Dublin	Foundered by breaking of engine; 6 drowned.
20	1829	Dunbarton Castle	Glasgow	Explosion of boiler; very violent.
21	1829	Britannia	Glasgow	Wrecked; driven into Donaghedee harbor.
22	1829	Suffolk	Newcastle	Fire from coals; in imminent danger, but saved.
23	1830	City of Dublin	Liverpool	Fire; put out by the engines.
24	1830	Hercules	Greenock	Explosion of boiler; master scalded.
25	1830	Frolic	Bristol and Tenby	Wrecked on Naas sands; all perished; number unknown.
26	1830	Suffolk	Newcastle	Wrecked at the entrance of the Tyne.
27	1830	St. George	Liverpool	Wrecked on the Isle of Man.
28	1831	H. M. S. Alban and Ipswich	Thames	Collision in the daytime.
29	1831	Union and Firefly	Thames	Collision; both rendered complete wrecks.
30	1831	Rothsay Castle	Liverpool	Wrecked near Beaumaris; 127 perished.
31	1831	St. Patrick	Dublin	Wrecked on Waterford rocks.
32	1831	London Merchant	London	Fire; from spontaneous ignition of coals.
33	1831	Royal William	Quebec to Halifax	Boiler injured; a hole burnt in one side.
34	1833	Superb	Liverpool	Wrecked in Liverpool bay.
35	1833	Erin	London and Dublin	Foundered near Lundy island; all on board perished; number unknown.
36	1833	Ardincaple	Newcastle	Imminent hazard of wreck; 7 persons perished.
37	1833	Nottingham	Liverpool	Wrecked near Larne bay; was raised again.
38	1833	City of Waterford		Wrecked on the coast of Portugal.
39	1833	Thetis	Liverpool	Fire from coals; burnt to water's edge and scuttled.
40	1833	Water Witch	Bristol	Wrecked; two lives lost.
41	1833	Lord Blayney	Liverpool	Wrecked in Liverpool bay; all on board perished; supposed 64 persons.
42	1834	Leeds	Liverpool	Wrecked near Holyhead.

SCHEDULE No. 2—Continued.

No.	Year.	Name of vessel.	Where employed.	Nature of accident.
43	1834	Superb - - -	London and Hamburg -	Foundered in North Sea; all on board perished.
44	1834	St. Winifred - -	- - - -	Fire; destroyed at Leghorn.
45	1834	Herald - - -	Bristol - - -	Explosion of boiler.
46	1835	Irishman and Queen of the Isles - -	Liverpool - -	Collision on the Mersey; very violent; 1 life lost.
47	1835	Medway - -	Thames - - -	Fire; occasioned by proximity of woodwork to the funnel.
48	1835	Earl Grey - -	Glasgow - -	Explosion; 10 lives lost; many severely injured: a previous explosion on the same vessel; also a fire.
49	1835	Ardincaple - -	Newcastle - -	Imminent danger of wreck or foundering.
50	1835	Athol - - -	Newcastle and Dundee -	Wrecked in a gale, near Coquette island.
51	1835	Prince Frederick -	Hull and London -	Wrecked off Yarmouth; 2 lives lost.
52	1835	Vale of Clwyd - -	Liverpool - -	Foundered in the Mersey.
53	1836	Ben Lomond - -	Newhaven and Stirling -	Fire; two steamers took off the passengers and crew.
54	1836	- - - -	From Liverpool to Rhyl	Imminent danger; passengers were saved by fishermen.
55	1836	Maid of Islay - -	Leith - - -	Wrecked and sunk off St. David's.
56	1836	Rob Roy - -	Thames - - -	Collision; run down by another steamer, and sunk near the Nore.
57	1836	Freedom - -	Stockton - -	Explosion of boiler; (tug-boat) 1 man killed.
58	1836	Magnet and Red Rover -	London and Margate -	Collision; Red Rover sunk.
59	1836	City of Glasgow -	Glasgow - -	Collision in the Clyde.
60	1836	Antelope - -	Liverpool - -	Collision in the night; many lives saved with difficulty.

61	1836	London	Hull to London	Fire; burnt to water's edge, and run on shore.
62	1836	Nora Creina	Ireland to London	Wrecked off the Isle of Sheppey.
63	1837	Union	Hull	Explosion of boiler; 24 persons killed; many much injured.
64	1837	Medway	Gravesend	Fire; burnt to a wreck; 2 lives lost.
65	1837	Monarch and Apollo	Thames	Collision: Apollo was sunk; 3 persons drowned.
66	1837	Don Juan	Gibraltar to England	Wrecked on Tarifa Point.
67	1837	Albion	Bristol	Wrecked in Jack's Sound.
68	1837	Royal William and Tagus	English channel	Collision; near being sunk.
69	1837	Worcester	Chepstow	Fire; totally destroyed.
70	1837	Maid of Bute	Clyde	Fire; scuttled and sunk.
71	1838	Killarney	Bristol to Cork	Wrecked on coast of Ireland; 29 persons lost and 600 hogs.
72	1838	Kilkenny	Waterford to London	Collision at sea with a sloop.
73	1838	Victoria	Hull to London	Explosion of boilers; 5 killed.
74	1838	Victoria	Hull to London	2d explosion; 9 killed.
75	1838	James Gallocher	Glasgow	Explosion of boiler; 2 killed, several much injured.
76	1838	William Stanley	Liverpool	Explosion of boiler; several persons injured.
77	1838	Antelope	Glasgow	Explosion or rupture; 18 head of cattle destroyed.
78	1838	Forfarshire	Hull to Dundee	Wrecked near Fern islands; 45 persons lost.
79	1838	Vivid	North Shields	Explosion of fire-tube; 2 persons killed.
80	1838	Tweedside	Leith and Newcastle	On fire, &c.; vessel and passengers saved by Royal Adelaide.
81	1838	Northern Yacht	Leith and Newcastle	Foundered with all on board; supposed to be 40 persons.
82	1838	Hope	Sunderland	Foundered in harbor by accident.
83	1838	Thames and Shannon	Off Brighton	Collision; Thames saved from sinking by having 3 boilers.
84	1838	St. Patrick	Dublin and Bristol	Wrecked on Waterford rocks.
85	1838	Tarbert Castle	Glasgow	Wrecked in gale on Loch Fyne.
86	1839	Falcon	Hull	Fire; no buckets; came into port on fire.

SCHEDULE No. 2—Continued.

No.	Year.	Name of vessel.	Where employed.	Nature of accident.
87	1839	Aurora	Glasgow and Belfast	Imminent danger of wreck or foundering.
88	1839	Herald	Ireland to Liverpool	Wrecked off Strangford.
89	1839	St. David	Liverpool and Newry	Imminent danger of foundering; of 150 passengers, 3 died of excessive cold; 70 cattle were thrown overboard.
90	1839	Abbey	Newcastle to Liverpool	Wrecked at the Isle of Islay.
91	1839	Urgent	Liverpool	Explosion of boiler; 8 or 9 persons scalded.
92	1839	Morning Star	North Shields	Explosion of boiler; 2 persons killed.

To the foregoing instances of wrecks, founderings, imminent perils, fires, and explosions of English steamvessels, may be added the following. Many others probably remain unknown:

No.	Name of vessel.	Where employed.	Nature of accident.
93	Meteor -	Portland -	Wrecked; year unknown.
94	Dasher -	Port Patrick -	Do. Do.
95	Ocean -	London -	Fire; subdued after imminent hazard.
96	Royal Tar -	London -	Imminent danger of foundering in the Bay of Biscay.
97	Victoria -	Liverpool -	Imminent danger of wreck; saved by a pilot-boat.
98	Shamrock -	Waterford -	Overset and filled.
99	Royal Tar -	St. Johns, N. B.	Fire; totally destroyed Oct., 1836; 30 lives lost.
100	Solway -	Carlisle -	Imminent danger of foundering in the Irish channel, Sept., 1839; reached Port Logan in a sinking state.
101	John Bull -	Montreal -	Fire; totally destroyed June, 1839; about 20 lives lost.

No. 3.

Known accidents and disasters to American steamboats since the law of 1838.

Date.	Name of vessel.	Where employed.	Nature of accident.
1838.			
Oct. 27	Cynthia -	Detroit river -	Burnt; passengers and crew saved by running on shore.
Nov. 25	Gen. Brown	Mississippi -	Explosion; 30 lives lost.
1839.			
January	Clarendon -	Sav. & Darien	Burnt; crew and passengers saved.
January	Ploughboy -	Mobile -	Sunk on arriving at Mobile.
January	Somerville -	Mississippi -	Sunk.
Febr'ry	Oswego -	Ohio -	Sunk near the mouth of the Kentucky.
Febr'ry	Alert -	Mississippi -	Eruption of steam; 4 scalded.
Febr'ry	Alice -	Pearl river -	Sunk.
March -	Reporter -	Ohio -	Eruption of steam; 4 scalded.
March -	New York -	New Haven -	Burnt.

No. 3—Continued.

Date.	Name of vessel	Where employed.	Nature of accident.
1839.			
May -	Avalanche -	Ohio -	Eruption or collapse; 5 killed.
May -	Rhine -	Missouri -	Explosion
May -	Pilot -	Mississippi -	Explosion or collapse.
May -	Pontchartrain	N. Orleans for Tampico -	Explosion.
May -	Geo. Collier	Mississippi -	Eruption of steam; 45 killed or scalded.
May -	Erie -	Hudson river	Collapse; 1 slightly wounded.
May -	Bee -	Arkansas -	Sunk.
May -	Indian -	Arkansas -	Sunk.
May -	Buckeye -	Mississippi -	Explosion; several killed or wounded.
June -	Empire -	Ohio -	Sunk.
June -	Massillon -	Ohio -	Collision and erupt'n of steam.
June -	Tennessee -	Cumberland river -	Burnt and sunk; passengers saved.
Nov. -	Wilmington	Mississippi -	Explosion; nineteen killed or wounded.
1840 -	Gallatin -	Cumberland river -	Collapse; 3 scalded.
1840 -	Lexington -	Long Island Sound -	Burnt; about 124 lives lost.

It may be seen that the most numerous and fatal of the accidents by steam have happened soon after the semi-annual inspections of the first of April and October. This fact will not appear surprising to practical men, who fully understand that the care and skill of official inspectors cannot be advantageously substituted for the uncontrolled vigilance and practical knowledge and skill of those who are in the constant care and superintendence of the boats and engines, and to whom a good reputation, the desire of safety, and the love of life, afford stronger and more efficient motives to correct action than can ever be furnished by the requirements or penalties of any special enactments of the legislative power.

The Cincinnati Gazette is stated to have published a list of steamboat disasters on the western waters during the last year. The sum total of losses is 40: of this number 32 were an entire loss; snagged, 21; struck rocks or other obstacles, 7; burnt, 5; burst their boilers, 4; run into by other boats, 3—40. There were snagged on the lower Mississippi, 11; on the Missouri, 4; on the Ohio, 4; on the Yazoo, 1; on the Red river, 1. It is remarkable that a majority of the boats were snagged on their downward trips. Lives lost, by bursting boilers, 39; by other causes, 6. Total, 45. The amount of property destroyed, in boats and their cargoes, is supposed to be not less than a million of dollars.

On events like these, the provisions of statutory law can have but little influence, except as they may operate to deter the men of means, foresight, and mental ability, from a business already too hazardous to their private interests, and which, most unwisely, has been made subject to the proscriptive action of the popular press and of the National Legislature.

No. 4.

Losses in ordinary navigation, and the comparative hazard of navigation by steam.

Some of the following paragraphs are taken from a communication made to the Secretary of the Treasury by one of the memorialists:

"So alarming have been the accidents in steam-navigation on our western rivers and elsewhere, as to induce a belief in the minds of some that of all modes of conveyance this is the most hazardous. That a degree of danger has attended this mode of travelling, which ought to be lessened or avoided, it were vain to deny. But when we reflect on the recent origin of the art, and the vast numbers of persons who are transported by its means; and when we also consider the exposure and comparative accidents of other modes of navigation and means of conveyance, this impression will be materially altered; and we shall rather have cause to wonder that, under all the circumstances of the case, so small a fraction of the travelling public have become victims to this hazard. We have, indeed, a fearful list of steamboat explosions; but the sufferings and fatalities which have attended other modes of transport and conveyance pass off with but little notice, as common occurrences, and their statistics are seldom known. Consequently, the public mind does not become excited in contemplating these casualties, which are treated only as evils which are incident to the common lot of man.

"It appears, from statements in the London Nautical Magazine, that the whole loss of property in British vessels by shipwreck or foundering is estimated at £3,000,000 sterling, annually; and the annual loss of life at sea at not less than 1,000 persons, not including the numerous losses of life on their own coast.

"As regards our own navigation, we find the following notice in the Sailor's Magazine for January, 1838:

"'*Shipwrecks in the year* 1837.

"'During the year past there has been published, in the Sailor's Magazine, a monthly list of shipwrecks which have occurred, principally of American vessels, and which have been published from time to time in various newspapers. Those only have been selected which resulted in a total loss of the vessel. The number of vessels thus reported during the year is as follows: ninety-four ships and barks, one hundred and thirty-five brigs, two hundred and thirty-four schooners, twelve sloops, and fifteen steamboats: making a total of four hundred and ninety-three vessels which have been wrecked. Of these, forty-three were lost toward the close of the previous year, though the account was not published till the

commencement of this; thirty-eight were lost in the month of January, fifty-four in February, twenty-four in March, thirty in April, nineteen in May, fifteen in June, forty-two in July, fifty in August, thirty-two in September, forty-three in October, forty-three in November, and six in December. The precise time when the remaining vessels were lost could not be satisfactorily ascertained.

"'In the abovenamed vessels one thousand two hundred and ninety-five lives are reported as being lost. This, probably, is but a part of the whole; for, in many instances, the crew are spoken of as missing, and in other cases nothing is said, where, perhaps, there was a total loss.'

"This statement is said to comprise no deaths by steamboats, except in cases where the vessel was totally lost. On the other hand, a very large proportion of the fatal accidents in ordinary navigation must have escaped the knowledge of the inquirer.

"Now, in view of this immense waste of life, let it be well considered that, in the art and practice of navigation other than by steam, the world has had the experience of more than four thousand years, and the efforts and intellect of many generations have been tasked for its greater security; while, on the other hand, *a quarter of a century has scarcely elapsed* since the powers of steam became prominently known in navigation, and we have, as yet, only witnessed the brief *infancy* of its application to this important purpose. Surely, then, it is not surprising that disastrous and fatal accidents should sometimes have attended its use. There is cause for astonishment, rather, that so great a degree of average security should have been attained in so brief a period.

"Each great district of our widely extended country possesses its own peculiar facilities and hazards in this species of navigation, and exhibits, also, different stages of improvement and security in the use of steam. In this quarter, the average degree of security enjoyed by passengers in our steamboats is certainly greater than is possessed by persons who walk the streets of our large cities. During the last five years, *millions* of passengers have been carried on the steamboats which run from this city (New York), and, among all these, the catalogue of deaths by steam explosions is almost inappreciable.

"It is probably true, that in hardly any other circumstances in which such numbers have been placed, has the occurrence of mortality been so entirely wanting. It is with a strong sense of injustice, therefore, that those who are engaged in this important and not always profitable avocation have found themselves selected as the objects of special, and, seemingly, invidious legislation."

Disasters at sea in the year 1839.

A record has been kept at the office of the American Seamen's Friend Society, during the year just closed, as in past years, of disasters at sea, so far as they could be ascertained, which resulted in a total loss of the vessel. The following is the result:

The whole number of vessels lost is 442.			
Of these there were,	Ships and barks	- -	74
" "	Brigs - - - -		124
" "	Schooners - - -		187
" "	Sloops - - - -		16

Of these there were, Steamboats - - -	9
" " Unknown - - -	32
	442
Of these there were lost, toward the close of 1838, but were reported in 1839 - - - -	52
Wrecked in January - - - - -	26
" February - - - -	27
" March - - - - -	32
" April - - - - -	21
" May - - - - -	29
" June - - - - -	18
" July - - - - -	15
" August - - - - -	29
" September - - - -	64
" October - - - -	30
" November - - - -	27
" December - - - -	8
Time unknown - - - -	61

Added to the above entire and known losses, there have been reported thirty-seven missing vessels during the year, which, with their crews, have most probably been entirely lost. Five hundred and thirty-seven lives have been reported as lost; but the loss of life is undoubtedly much greater than this, as many vessels were reported as abandoned, or bottom-up, where the crew was missing, and no intelligence has been received from them. The above facts speak a language concerning the sorrows of seamen not to be misunderstood; and they should be most solemnly pondered by those who have a heart to feel and a hand to relieve.—*Sailor's Magazine*, *January*, 1840.

In the foregoing list* we have reported the loss of 84 vessels in the month of December, and the loss of 89 lives; which, if added to the 89 vessels and 90 lives lost in the great gale of the 15th of that month, and to eight other vessels reported as lost in December in our last Magazine, we have a total of 181 vessels and 179 lives lost within that month.—*Sailor's Magazine*, *February*, 1840.

In addition to the above, the Sailor's Magazine for March, 1840, also records the loss, by fire, foundering, or wreck, of fifteen more vessels in 1839; and reports, also, in February and March, eleven vessels as missing, for the safety of which, with their crews and passengers, little or no hopes are entertained. The accounts of *total loss* for 1839, so far as heard, stand as follows:

Losses mentioned in the Magazine for January -	884
" " " " February -	173
" and missing " March -	11
	1068
Deduct steamvessels included in the above	9
Total	1059

* This detailed list is omitted here.

Thus showing the total loss of more than one thousand vessels, already ascertained, and the probable loss of between one and two thousand valuable lives, all in a single year!

Are these immense losses of life and property, which had been entirely subjected to the care and control, discretion or indiscretion, of the owners of vessels and of their several commanders, while at a distance from all wholesome oversight and restraint, less worthy of the special interference of the power which is authorized to *regulate commerce*, than the persons and property embarked in steamboats, which are under the almost constant oversight of the owners and the public? Or, must the result of popular misapprehensions and erroneous excitements be substituted for more sober legislation, in controlling the business concerns of this growing republic?

It is believed that the statistics which are found in the foregoing table, of the steam-navigation of the port of New York, may not unfairly represent *all the steam-navigation of the United States*, with the exception of the Mississippi and its branches, or the waters which discharge in the gulf of Mexico. With perhaps this exception, both the existing and the contemplated legislation appear to be almost wholly unwarranted, either by the origin, progress, or present state, of the art of steam-navigation.

The southwestern waters, however, appear subject to greatly increased hazards, which may have resulted, mainly, from a less perfect system of practical engineering, which has been imposed either by choice or necessity; from less perfect means of outfit and repair than are found in older States or countries; and, above all, from the greater and multiplied dangers of their local navigation. It may be well questioned, however, if, even here, the new legislation be well adapted to the end in view. If, as is believed, there be errors in the western practice, these will doubtless be abandoned so soon as they are practically seen and felt to be errors. But the character of the American people is greatly mistaken if it is for a moment supposed that a combination of prescribed formulas, with inquisitorial and penal enactments, will remedy evils which are beyond the reach of professional knowledge and pride, and an enlightened self-interest.

The true character of hazard of the western steam-navigation is too often but little understood, or but imperfectly appreciated. It has been eloquently and justly described by the Hon. Mr. Rumsey, of Kentucky, on the floor of Congress, who vindicates the memory of the founders of steam-navigation in America, and the results of their labors, as follows:

"Sir, you have no arithmetic of powers vast enough by which to estimate the benefits of the steamboat in a pecuniary point of view alone. Their labors, too, have tended, in no small degree, *to the preservation of human life*. I am aware that the truth of the last assertion may not be universally admitted; but it will scarcely be questioned, at least by a western or southwestern man, who recollects the old mode of conducting our commerce. Small as the commerce was before the introduction of the steamboat, it drew off a larger portion of the population than is now necessary to transact it, although so immensely extended. Even then, more died in the long and exposed and laborious voyages in keels and barges, or the exhausting return by land, under a vertical sun, than now perish by steamboat explosions. But they dropped off one by one; they sank obscurely into the grave by the wayside; or, after reaching their homes, fell victims to disease incurred by a sojourn and travel in southern climes.

The consumption of life, though known to be great in the aggregate, happening so much in detail, made no public impression; but now every steamboat accident creates a sensation, and is proclaimed in the universal press of the country. If the mighty commerce now in progress on the western waters had to be conducted in the old way, it would require the agency of so many individuals that it would not be long before the sides of the public roads, from New Orleans to the upper States, and the banks of the great river which pours into the gulf the congregated waters of nearly half a continent, would be almost continued graveyards."

APPENDIX B.

Letter to the Secretary of the Treasury.

NEW YORK, *December* 26, 1838.

SIR: Having recently been served with a copy of the resolution of Congress, moved by Mr. Sergeant, for obtaining information respecting the use of the steam-engine in the United States, in navigation or otherwise, and the accidents which have resulted therefrom, I am led to believe that the inquiry will be best answered by a concise statement of my own observation and practice for the last sixteen years, during which time I have been chiefly engaged in the construction or management of steamvessels.

When I first engaged in the application of steam to navigation, there were, as now, two systems of engineering practised in our steamboats. One of these, the Bolton and Watt, or low-pressure system, had been introduced by Fulton, in which the working power was mainly derived from steam of low temperature and expansive force, working upon an effective condensation; the other, the high-pressure system, in which steam of high elastic force is worked against the pressure of the atmosphere. The latter system was early introduced in this country by the late Oliver Evans, who was distinguished for his mechanical talents, and who perhaps exceeded all his contemporaries in his just apprehension and prescience of the powers and advantages of the steam-engine, as applicable to railroads and to navigation.

My first practical acquaintance with the steam-engine was under the high-pressure system; the adoption of which, in this case, grew out of circumstances not under my control. But an attentive consideration of the principles and practice of the low-pressure system, served to convince me that the claims to superiority, both for efficiency and safety, which had been mutually set up by the advocates of the two systems, could not be justly maintained.

It appeared obvious that the useful effect of highly elastic steam could be greatly increased by acting with lesser pressure on the surface of a larger piston, working on an effective condensation; while the tension and wearing of the different parts, and the danger of explosion common to high-pressure engines, would thus be materially lessened. It appeared equally certain that the engine of Bolton and Watt could be rendered

more useful and efficient by adapting it to steam of greater pressure and elasticity than was at that time employed; and that by proper modifications in the structure of the boilers, a degree of safety could also be secured which had never yet been attained. The high-pressure system, as then practised, required a tension of steam approaching, as I conceived, too near the estimated strength of the boilers in which it was generated, to be deemed safe in all circumstances; a consideration of the highest importance in navigation. It also appeared that the use of low pressure steam, after the English method, with weak boilers, in which any accidental increase of pressure to the amount of perhaps half an atmosphere, could hardly fail to be attended with fatal disaster, was equally unsafe; and that this practice, although universally sanctioned in England, ought not to be followed in our steam-navigation.

From these considerations, it appeared to me evident that the greatest degree of safety and efficiency could only be obtained by combining, to some extent, the peculiarities of the two systems, and by adopting such forms of structure in the boilers as should afford the greatest attainable amount of surplus strength, between the maximum working pressure and the point of actual danger to the boiler. I determined, therefore, that in all cases under my control, the extra or surplus strength of the boiler should always be as great as might be fairly practicable; a principle which, after this lapse of time, I have found sufficient reason to recommend to others for adoption.

Upon this principle of the greatest attainable strength, were also constructed the boilers of the high-pressure steamboat in which, as before mentioned, I was first led to engage. This steamboat was, for the period of four years, under my immediate observation before being dismantled, and during this time, no injury by explosion or eruption of steam, and, probably, not the least hazard thereof, was known to occur; nor do I find reason to believe that, in ordinary hands, the use of these boilers could have been rendered dangerous, either to the passengers on board or to those intrusted with their management.

In the meantime, I was engaged in the first successful attempt to establish steam navigation on the Connecticut river, between the cities of Hartford and New York, by means of a competent steamboat of low-pressure construction. In this case, my own views of safety and efficiency, as before mentioned, would have required an important modification, and addition of strength, in the boiler which was furnished for this boat. At this period, however, the influence which was exercised upon public opinion by the associates and friends of Fulton and Livingston, through the medium of the press and the intercourse between their captains and the travelling public, had extensively induced the belief that the plans adopted in the Fulton boats, and those only, were safe and proper; and a general conformity thereto was deemed to be indispensable, by those who professed to represent the public interests. In this case, therefore, the plan of construction adopted for the boilers and engine was like that of other low-pressure engines then building for the New York waters; the boiler, which was of iron, being large, and the engine fitted with D slide valves, and adapted to a speed in the piston of 160 to 200 feet per minute, like the English marine-engine now in use. It is but just to state, however, that the boiler in question, and also most of those which were used in the Fulton boats, were of greater strength than the boilers which are

commonly used in England for low-pressure engines. But, on the other hand, the advantages of a greater expansive power were beginning to be understood; and as confidence in the strength of these boilers increased, the practice of increasing the working pressure upon them gradually gained ground, so as ultimately to neutralize the advantage of the increased strength which had been given to them beyond that of the original English models. This steamboat (the *Oliver Ellsworth*) commenced running between New York and Hartford in the spring of 1824, immediately after the removal of the restrictions in favor of Fulton and Livingston, by the decision of the Supreme Court of the United States; and my connexion with this boat terminated in the following year. I have noticed these facts as illustrating, in some degree, the chief cause of the explosions which have since occurred in the steamboats navigating on the various routs leading from the city of New York; and the name of this boat will hereafter appear in the catalogue of these accidents.

In 1824, '25, I was engaged in the construction of the steamvessels *Commerce* and *Swiftsure*, and the safety-barges and freighting vessels which have since been towed on the Hudson chiefly by these steamers; having acted as principal engineer and general agent of "The Steam Navigation Company," to which these vessels belonged.* Having been left free in the application of means to ends, except as measurably controlled by the opinions and habits of the contractors and artificers employed, I at once adopted the strongest form of boiler that appeared applicable to the general combinations which were then chosen. The plan of combining the advantages of the high with the low-pressure system, at an intermediate pressure of steam, was adopted for these vessels, as being best suited to the service for which they were designed. At that early stage of our improvements in the marine engine, the plan of uniting these advantages in a single working cylinder, and of making a more efficient application of them by means of an increased velocity of the piston, had not come into practice.† Double engines were therefore employed, comprising two cylinders of unequal diameters, the smaller one receiving the steam from the boilers and delivering it expansively to the larger one; the latter being worked upon an effective condensation. These vessels, with their engines, have been employed for fourteen years, with little modification, and mostly under severe duty; but no accident of an explosive or eruptive character has ever occurred, and they appear capable of rendering good service for several years yet to come. The boilers, during this period, have been twice renewed, on plans combining additional strength and convenience.

I may here state that no accident from the explosion or rupture of a steam boiler has ever occurred in the steamboats under my particular charge; and the remark might also be extended to other steamboats, which have been furnished with boilers made under my directions. That this result has been chiefly owing to the superior care or skill of my sub-

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* In this communication I use the term "engineer" in the double sense which common usage has assigned to it in this country, it being descriptive alike of him who controls and directs the specific use and combination of materials which are needful to a machine or superstructure, and of one who is employed in the ordinary charge of a steam-engine.

† For establishing the advantages of this simple combination, if I mistake not, we are mainly indebted to the practical talent of Robert L. Stevens, Esq.

ordinates, who have had the immediate charge of the boilers and engines, I cannot believe; for, trustworthy as were most of these men, they have partaken of the general character of their fellow men, in and out of this profession, and have, probably, no better claims to infallibility. Boilers of a structure which afford the proper degree of surplus strength may be injured as well as others, by the carelessness or neglect of those in immediate charge; but are not likely, even with bad management, to destroy life by explosion.

The bearing of the considerations which have been stated should be considered as fully applicable to engines and boilers of every grade, whether for high or low pressure. Nor will the use of boilers of the greatest attainable strength, have any tendency to promote in the engineer a disposition for hazardous or untried adventures, nor to prevent him from appreciating those other substantial improvements in the art or science of engineering, as applied to steam navigation, which have been realized within the last fourteen years.

Having stated the general manner in which the steamboats and other vessels of the Steam Navigation Company have been constructed and managed, it is only necessary to add, that the sale or use of intoxicating liquors has not been allowed in these vessels for the last eight years, and I believe that this rule cannot be commended too strongly.

Explosions of boilers on the New York steamboats.

In May, 1824, the public were astounded by the disastrous explosion on board the *Etna*, while navigating the waters of our bay, a few miles from the city. The engine and boilers of this boat had been constructed upon the plans of Evans, and in conformity with his ultra views in favor of diminutive passages, both for the steam and supply of water: and she had recently been brought round from the Delaware, and employed between this city and the Raritan. No proper examination of the facts attending this case, such as the interests of the public and the profession required, was ever made; but, as near as could be ascertained from private statements, and the judicial testimony then published, the small pipe through which water was supplied to the boilers had become stopped, or nearly so, by incrustation; and the supply falling short, the boilers were too strongly heated upon their lower surface, and were then left to their fate, while the fire should exhaust itself. Upon this statement, however, I do not think it safe to rely, as all subsequent observation and inquiry have shown me that no statements are more to be distrusted than those which gain circulation under the terrors and excitements of these accidents. I had opportunity, however, to examine the remains of the ruptured boiler, which was of the cylindrical form, without flues, about thirty inches in diameter and twenty feet in length, and had been some time in use. The iron plates of the boiler were mainly sound and good, and from the manner in which the boiler was torn, it appeared that the rending, though sudden, was also progressive; and I felt desirous to ascertain, if possible, the first point of eruption. With this object, I traced back the rent from its final termination, on the main part of the boiler, and, supposing the parts again restored, successively, to their original position, followed the rent spirally around the boiler, to where it had separated from the opposite end, which had been projected from the boat, and lost in the river. At

this point, I found the line of separation passing through one of the riveted joints on the under side, which had stood directly over the fire; *and this joint showed itself to have been previously separated by a crack of long standing, and of considerable extent, in the line of rivets.* This older fracture, occupied the spaces between several contiguous rivets in one of the sheets, and, without doubt, had gradually attained the extent which was then discernable by its oxydated surface, owing to the frequent expansion and contraction of this part of the boiler, and aided, also, by the constant sagging effect of its weight, while supported only at its two extremities. I will here remark, that boilers of small or of moderate diameter should always be supported near their centres by lifting-bolts, passing through a strong beam above the boilers, or by some other arrangement which is equivalent thereto.

The pressure under which the boilers of the Etna were worked was said to be from 100 to 150 pounds to the square inch, and it is probable that this pressure had been greatly exceeded on some previous occasions.

The explosion of this high-pressure boat, so recently introduced upon our waters, occasioned the greatest excitement; and the opportunity was seized upon to prejudice and exasperate the public mind against the owners and managers of all steamboats which were furnished with *iron-boilers*—those then used in the Fulton boats being of copper; and especially was this odium directed against all those whose boats were supposed to approximate to the use of high pressure. Several new boats were then in the process of construction, and the owners of some of these felt themselves compelled to yield to the storm of prejudice in favor of copper-boilers of large and insecure construction, approximating to the old English models, with the general exception that the fire was placed within the body of the boiler, and the use of brick-work was dispensed with; and the old dogma of security in the *weakness*, instead of the strength of the boiler, now found numerous advocates. An active and intelligent gentleman, then acting as agent for one of the finest boats at that time building for our waters, on being remonstrated with for yielding his better judgment to this prejudice, and thus endangering the future security of his fellow-citizens who might become passengers, told me frankly that his owners, as well as himself, were fully convinced of the superior strength and safety of iron-boilers, and the advantages of modifying their structure; "but," said he, "we cannot resist public opinion; the people have been instructed that iron is an unsafe material for boilers, and that it is recklessly used because it is *cheapest.* It is beyond our power to disabuse them in this matter; and they threaten us, moreover, that, if we will not give them a boat with a copper-boiler, they will procure such a one and run it against us. We have concluded, therefore, to give them a copper-boiler, the strongest of its class, and have made up our minds that they have a perfect right to be scalded by copper-boilers if they insist on it." I lament to add, that the exercise of this "right," to the use of copper, was attended, within a few years, with a fearful destruction of life, as had been foretold.

I am sorry to add, that the conductors of our public journals were mainly instrumental in enforcing upon the owners of steamboats this false standard of safety, both as relates to the use of copper and to the form of the boiler; and that to this cause must be chiefly ascribed the unhappy destruction of human life which occurred in our New York steam-

boats during the ensuing eight years. Not that all boilers were, in consequence, made of copper; for, by far the greatest number brought into use were of iron, because of its known superior strength; but this untoward influence mainly controlled the structure of these boilers, which were generally confined to the strictly low-pressure form, exposing greatly expanded surfaces to the action of steam, without adequate support. Fortunately, some of those who were then engaged in the construction and management of steamboats, possessed more firmness than to yield to this influence, and in devising their combinations were governed only by their own knowledge and sense of the means proper to be used, in order to ensure both safety and efficiency; and in the steamboats so controlled, I am happy to state, such disasters have been entirely unknown.

About the same period, however, two other disasters, of a serious character, occurred in steamboats furnished with *copper-boilers*. One of these accidents, on board the *Fidelity*, seriously injured or caused the death of two or three persons.

The other case was on board the *Jersey*, one of the Fulton boats employed on the Jersey City ferry. This explosion was second in violence only to that of the Etna; and was less destructive merely from the absence of passengers to be exposed, there being fortunately but one or two persons on board at the time of the accident.

Another fatal disaster occurred also in 1825, with a low-pressure copper-boiler which had just been placed on board the steamboat *Patent*, in which the lamented Dodd and several other persons, who were exposed, lost their lives. Previous to this, also, the *Paragon*, one of Mr. Fulton's boats, running on the North river, met with a similar accident, which was attended with the loss of life. Again, at Elizabethtown point, fourteen miles from the city, in 1813, a low-pressure boiler on board the *Sea-Horse* had exploded, with a pressure of steam not exceeding five pounds to the square inch.* But the bearing of all these cases was strangely overlooked, and palliatives were to be found, or uncontrollable causes discovered, by invoking the aid of dangerous and unknown gases: or some unhappy fireman or engineer was made the scapegoat, who, by his undoubted misconduct or recklessness, had rendered dangerous and destructive, that which had previously been declared to be safe and incapable of serious mischief!

And now came the incitement of active competition on the navigable routes leading from this city, then newly thrown open to all competitors. Old steamboats were found too slow, and new ones were daily acquiring additional speed. So far as this result alone is concerned, this was as it should be; but unhappily, the greatly expanded boiler, whether of iron, or copper, being deemed stronger than was necessary for the pressure which had hitherto been used, must now bear a greater load, and gradually became worked more nearly to its full strength and capacity. In the summer of 1825, the *Constitution*, a new boat, collapsed one of the large irregular shaped flues in her iron boiler, when near Poughkeepsie, and killed or injured several persons. In this case some of the explosion theorists were content to admit that there was no want of water; but loud was the outcry which was again raised against iron-boilers.

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* Journal of the American Institute for September, 1838, page 646.

The next case in order is the explosion on board the steamboat *Legislator*, in 1825, while lying at our wharves, ready to start on her trip to New Brunswick. This boat was furnished with a low-pressure iron-boiler, of nine and a half feet in diameter, constructed by the late Robert McQueen, according to the then improved low-pressure pattern. The *interior* shell containing the furnace was about nine feet in lateral diameter, flattened into an ellipse at top, and supported on the outer shell at the bottom and sides by an occasional brace-bolt; the general use of these fastenings not having then received the sanction of our boiler-makers. The pressure of steam on the boiler at the time of this explosion was said to be between ten and thirteen inches by the mercurial gauge.* The interior portion of the boiler was violently torn and turned inside out, with the destruction of every thing near the boiler, and of the lives of five or six persons employed on the boat; but the outer shell, which was cylindrical, remained uninjured. On examining this boiler, I found that the rending was principally in its lower portions, and that if the parts were all turned back to their proper places, the last points to come together would be those portions at the bottom of the ash-pit beneath the furnace bars. At this point the iron was not more than three-sixteenths of an inch in thickness, and had separated into thin lamellated plates, not having united properly under the roller. Thus the rupture in this case evidently originated at the lowest part of the boiler, at the weakest point, and under a head of some six feet of water. But these facts were not investigated, and it was sagely assumed by manufacturers of boilers and other advocates of this stereotyped hypothesis, that this explosion could not possibly have happened had there been a competent supply of water in the boiler. On the other hand, I consider it demonstrable that a boiler of this size and construction, without a thorough system of bracing, is wholly unfit to sustain the ordinary pressure to which this boiler was exposed, and which the managers of the boat believed could be safely borne. But, instead of ascribing this disaster to its true cause, the imperfection of the favorite system of construction, the opportunity was taken to inflame the opposition to iron boilers, and to throw the odium of the disaster upon the perished firemen or engineer.

The year 1826 passed off with only one or two slight accidents of this kind among the New York boats: one on board the Hudson, employed on the East river; and another on the Franklin, then running upon the North river. Both these boats had low pressure iron boilers.

In the spring of 1827, the steamboat Oliver Ellsworth, on her passage from Hartford to New York, when six or eight miles west of Saybrook light-house, in a heavy sea and head wind, burst or collapsed the main flue of her boiler, which occasioned the loss of one passenger, the engineer, and one or two firemen. This case appears to have been universally set down by theorists as owing to extreme carelessness, and to the want of water in the boiler.† Mr. Penfield, the worthy engineer of this

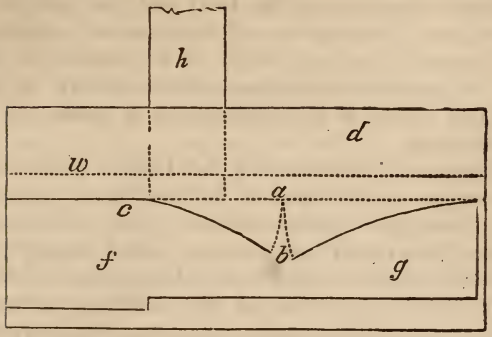
* The mercurial tube being bent in the form of a syphon, each inch of elevation causes a difference of two inches in the actual level of the mercury, and an elevation of thirteen inches in the open end of the tube, indicates the pressure of nearly thirteen pounds to each square inch.

† See certain well-intentioned communications in Document 21, House of Reps., 25th Cong., 3d Session.

boat, had acquired experience during four previous years in my employment, and I had ever found him a man of great care, prudence, and faithfulness. He had changed his employers, with my consent, on the opening of that season, in order to avail himself of a more tempting offer which was made him by the managers of the Oliver Ellsworth, on account of his known good qualities. He knew the value of the principle of surplus strength, under which he had acquired experience, and was well acquainted with the condition and management of the Oliver Ellsworth. His first effort, as he then informed me, was to induce the managers of this boat to introduce braces into their boiler, in order to secure the large main flue, which was *four feet* in diameter, made of quarter-inch iron, without other support than that afforded by the connexions at its two extremities. But his views of security were deemed as savoring too much of high pressure, and it was decided that a boiler which had occasionally sustained a pressure of 15 or 16 inches of steam by the mercurial gauge,(!) could be safely run with a pressure of 12 to 14 inches; and the too modest engineer had no remedy but submission. I had estimated a pressure of six inches as being safe for this boiler when constructed, while others of high authority in these matters then deemed it entirely safe with nine inches. On the evening of the accident, the engineer was watching both boiler and engine with great care and anxiety, being instructed to keep a full head of steam, in order to encounter with success a strong head wind and sea. He accordingly kept from twelve to thirteen inches, with a full head of water, and to prevent the latter from discharging into the cylinder by the motion of the boat, was obliged carefully to tend the throttle-valve, and was actually thus regulating the action of an *overfilled* boiler at the moment in which the explosion took place. He survived the disaster several weeks, and gave me from time to time, under no apparent bias but the love of truth, a far more circumstantial account of his care and management on this occasion, than can be here introduced. But his cares and anxieties were unavailing, and he was doomed to the infamy of having been the careless or rash instrument of destroying the lives of his fellow-beings, by the inconsiderate advocates of the common explosion theory, who, in opposition to all evidence, can decide by mere intuition, the want of water in the boiler and the criminality of the engineer!

Although confident in the accuracy of Mr. Penfield's statements, I did not fail to examine closely the condition of the boiler, after the accident. Its general construction was not unlike that of the Legislator; having an elliptical-shaped interior furnace of eight and a half feet in lateral diameter, and six feet in length, from which extended a circular main flue of twelve feet in length, and four feet in diameter; a smaller returning flue, of irregular form, leading back to a point near the furnace, where it turned upward through the top of the boiler, and was there joined to the chimney. This returning flue, on account of its irregular form, was partially sustained by means of a few brace-bolts, but no securities were provided for sustaining the great flue or interior shell of the boiler. A longitudinal outline, showing a vertical section through the centre of the main flue, is here represented:

A vertical section of the Oliver Ellsworth's first boiler.



f, furnace flue; *g*, main flue; *w*, water line; *d*, steam chamber; *h*, chimney; *a*, point of fracture, *b*, disruption. Scale. ⅛ inch to a foot, or 1 96.

On examining the parts which, in case of a deficiency of water, would have been first exposed to the action of the fire, it was found that neither the top of the furnace flue at *c*, immediately over the fire, nor the top of the main flue, on the same level, nor any other part of the flues, appeared to be in any manner affected by the heat; but, on the contrary, the iron on the upper part of the flue appeared to be, for the most part, as clean, and in as sound condition, as during the first use of the boiler, with but one exception, now to be noticed. This exception was found in the line of fracture at the point *b*, where the curved lines represent the position to which the highest point of the main flue had been depressed by the disruptive force, and by which the original fracture at *a* had been extended around nearly half of the circumference of the flue; the circular top of the latter, being depressed into the form of an inverted curve, extending from the fracture in opposite directions. Now, at the point *a*, (which is placed at *b*, by the disruption, as just mentioned), the trace of a previous fracture in the line of rivets was distinctly visible for some eight or ten inches, transversely to the top of the flue, which fracture, judging from its appearance, must have existed for a considerable time previous to the final disruption.

Nothing, therefore, could appear more certain than the fact of a full supply of water previous to and at the time of this accident; and the disruption was evidently caused by an amount of working pressure to which the diminished strength of the boiler, at this point, proved to be unequal, although the boiler had sometimes been worked with even a higher pressure, before the incipient fracture here noticed, had originated or become so extensive.

In the boilers of the Etna, as in other cases where the boilers have been long suspended by their two extremities, this insidious sort of fracture was induced at or near the *lower surface*, by the joint action of weight and unequal expansion; but the main flue of the Oliver Ellsworth was constantly surrounded by water, and pressed *upward* by a force equal to the whole weight of water displaced by this capacious flue, which, after deducting the weight of the flue, is equal to more than 10,000 pounds.* The

* The length of the furnace is included in the estimate.

fracture, in this case, therefore, was gradually induced at the *top* of the flue, which was also most exposed to heat and the unequal strain of expansion. The origin of this species of fracture may, perhaps, be referred to the process of manufacture, in which it is common to force the rivet-holes, which do not properly overlie each other, by driving a steel pin into the same; a practice which is well calculated to cause the sheets to separate in the line of rivets.

This disaster induced the owners of the Oliver Ellsworth to procure a heavy copper boiler, in compliance with the clamor against iron boilers, which on this occasion was again renewed. At a subsequent period this boat was purchased by myself and associates, and transferred to the Hudson river; care being taken to remove her large copper boiler, and to furnish her with a boiler constructed on the before-mentioned principle of giving the greatest practicable amount of strength, beyond the working pressure, that could conveniently be obtained. The result has been that this boat has not only run with entire safety, but is, even now, with her antiquated engine, much more serviceable and efficient than when employed upon her original route, although the steamers constructed contemporaneously with this vessel have disappeared from our waters. In truth, I consider this steamboat as being at this day far more safe from fatal casualties than most of the steamboats now on our waters. The boiler is sometimes worked with a pressure of two atmospheres above the common boiling point, while it possesses a strength which will bear a pressure of eight atmospheres, leaving a range of strength equal to more than six atmospheres between the maximum working pressure and the point of proximate hazard; and this is believed to have been accomplished without any sacrifice either of original cost or of economy in the use of fuel. If a proportionate range of surplus strength had always been given to the boilers of marine engines, it is believed that steamboat explosions would seldom, if ever, have been heard of, notwithstanding the hypotheses which are so generally and confidently relied upon as accounting for these explosions.

In April, 1830, the steamboat *Chief Justice Marshall*, employed on the Hudson, burst her boiler, while landing passengers at Newburg, by which 11 persons were killed and many others wounded. This boiler was of stout copper, and very strongly built, on the "low pressure plan," and was more thoroughly *braced*, it is believed, than any other boiler of its date. The structure, however, was a very large one, on the general plan of the boilers in the Legislator, Oliver Ellsworth, and other boats of that day; the main flue being also circular, and five feet or more in diameter. The disruption, we are informed, "was ten feet back from the front of the boiler, and was probably eight feet in length, by four in width, *commencing nearly at the bottom of the flue, and extending upward a little over one-half of its diameter.*

We may safely infer that this explosion, commencing near the bottom of the boiler, and four to six feet below the water-line, was not occasioned by want of water. The principal engineer, who survived the accident a few hours, stated to the captain, near his last moments, that there was less than sixteen inches pressure on the boiler at the time, which is probably true; and it is admitted that the steam was "blowing off" through the safety-valve during the entire stoppage till the accident occurred. That there was some unknown defect in the boiler, it was supposed by the engineer, is not improbable; but neither engineers nor captains had then

learned, that such a structure of such material, was unsuited for that pressure. The ardent advocates of copper boilers and the zealous manufacturers of public opinion, were now liberal in their denunciations of the unfortunate engineer, who, in their view, by the clearest evidence, had been guilty of criminal neglect or recklessness, in allowing the water to become so wasted or reduced as to occasion this dire catastrophe. Many persons insisted that nearly all the water in the boiler must have been previously exhausted. To have sought for *facts* on which to support so grave a conclusion, would have been deemed an insult to common sense; especially as persons had been brought forward, who, under their oath, had testified to the previous warning which they had heard in the shrill and piercing *whistle* with which the discharge of steam was attended previous to the explosion. But, alas, for common sense! this thrilling whistle had pierced the ears of the writer, most uncomfortably, thrice in a week for several previous years, while in his office in the vicinity of the wharf occupied by this steamboat; and was known to be owing to some unfortunate peculiarity in the construction of the safety-valve or its appendages! It is hardly necessary to add that the upper and most exposed surface of the flues of this boiler were found, by good judges, to exhibit no traces whatever of injury by heat—a circumstance which is entirely incompatible with the supposed enormous deficiency in the supply of water.

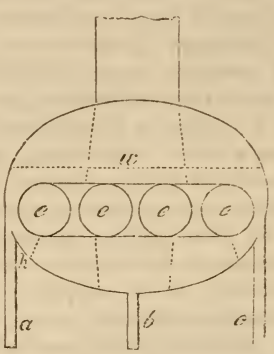
The owners of this steamboat, having once been made the instruments or victims of a factitious public opinion, now adopted a wiser course, and procured two strong *iron* boilers, of more moderate dimensions and better suited to the pressure of sixteen or eighteen inches which their engine required; and during the remaining years of her service, this boat was run without injury to her boilers. It may be noticed that this disaster was more fatal in its results than all the explosions or disruptions of iron boilers which had then occurred on the northern and eastern routes from this city. Had this boiler been constructed of iron, and secured in the same manner, it is not probable that it would have given way, even with an addition of several pounds to its maximum working pressure, had such addition been fairly practicable.

In the same year there occurred a similar disaster on board the steamboat *United States*, running between New York and New Haven, by which several lives were lost. The boiler of this boat was of iron, but constructed on a plan similar to those which have been mentioned. The boat was opposite Blackwell's island at the time of the accident, with twelve and a half inches of pressure; having frequently worked with fourteen inches. This boiler, which had been recently repaired, also gave out near the bottom of the main flue, its upper portions and the roof of the furnace remaining uninjured; and yet we continually hear that nearly all of these accidents have been occasioned by the want of sufficient water in the boiler! Notwithstanding the severe lesson then recently received from the Chief Justice Marshall, and the explosion of almost every copper boiler which had been continued in use, we were again warned by the public journals against the hazard and cupidity of using iron boilers.

In 1831, the boiler of the steamboat *General Jackson* exploded on the Hudson, at Grassy point, while stopping at the wharf. This was a large, low-pressure iron boiler, carrying, it is said, fourteen inches of pressure at the time of the disaster; the safety-valve being open, and the steam blowing off for some minutes previous. But the escape of steam was not, per-

haps, as freely allowed as it should have been. The boiler being under deck, and breaking out through its bottom, the force of the explosion threw the boiler out of the boat and into the river, demolishing the deck and causing the vessel to sink at the wharf. The boiler was a large and unwieldy structure. It was partially braced, but without a thorough system of these fastenings, and was elliptical in its form; being, if I mistake not, about eleven feet in its lateral diameter, and presenting a cross section of nearly the annexed form:

Cross section of the boiler of the steamboat General Jackson.



Scale $\frac{1}{8}$ inch to a foot, or 1-96.

The fire was beneath the boiler, instead of within it as in the foregoing cases; the dependent portions *a b c* being what are technically called water-legs, and riveted to the main shell of the boiler, which was here perforated with large openings to allow of a free circulation of the water. The return flues *e e e e* were circular, and united at their extremities by attachments, and terminating in a square cross flue, which communicated with the chimney; and *w* shows the water-line. The rending, when traced to its point of commencement, appeared to have originated at the angle *h*, where the water-legs joined to the boiler;* and whatever influence the large perforations in the shell may have had in weakening the structure, it is certain that the riveted joints on the line of disruption showed several preliminary fractures of considerable extent, of the same character as those already pointed out in the boilers of the Etna and the Oliver Ellsworth, and one of these was particularly obvious at the point *h*.† The other portions of the boiler appeared to have been previously in good order; and the flues and their flat connexions, though soonest exposed to any deficiency of water, were as entire and as perfect in their condition as ever. Nothing, however, could exceed the storm of indignation which was raised against the captain and the suffering engineer for their supposed criminal negligence or recklessness in this matter; and instead of

* Under this point, also, the planks were started from the bottom of the boat, which caused her to sink.

† When this kind of fracture occurs on the outward lapping of the sheets, it usually causes a leak, and is easily discovered; but when it occurs on the *inner* lap of the boiler iron, it sometimes will remain tight for a long period. I have known this fracture to extend, in a high-pressure boiler, to *fourteen inches* before it was detected; which, with the ultra pressure sometimes used on the Mississippi, would surely have caused an explosion.

ascribing the disaster to the obvious weakness of the boiler, iron boilers were, as before, held to be worthy of all proscription.

We now arrive at a period when the old low-pressure boilers, and those which were constructed according to the requirements of public opinion at the epoch of the Etna's explosion, had been destroyed or laid aside. A gradual improvement had, in the meantime, taken place in the construction of boilers, which, although leaving much to be accomplished, had gone far to remove the immediate danger of explosion. But, with the new method of working the steam expansively, in a single engine of increased stroke, there was also introduced an extension of the steam-chamber of the boiler, vertically, around the flue of the chimney; this extension being of the cylindrical form, and technically known as the *steam-chimney.* In the summer of 1832, the steamboat *Ohio*, one of the largest on the Hudson, burst the interior shell of this appendage to her boiler; by which five persons lost their lives, three of whom were passengers. The boiler was under a pressure of fourteen inches at the time, and was often worked with eighteen inches, and sometimes with twenty inches. The disruption took place about a foot above the water-line, in that part of the flue which is ordinarily subject to a high degree of heat. *This flue was three and a half feet in diameter*, unsupported by suitable brace-bolts; and, from the description of Mr. Ewbank, published in the Journal of the Franklin Institute, it appears that the iron had been much injured by previous heating and exposure. That such a flue should have given way under the above pressure is not at all surprising. Since that period a like accident has occurred in our harbor, in one of the Charleston steamboats, by which several lives were also lost, chiefly of her own crew.*

But we have still to notice a more serious disaster than either of the foregoing, which has attended the use of copper boilers. The disruption of the boiler of the Oliver Ellsworth, and the warfare of the press against the use of iron-boilers, induced the owners of that boat to provide a copper boiler, as the only means of restoring confidence. This boiler was of unusual thickness, and secured in a manner surpassing that which had been previously practised. The new boiler was worked with a pressure of thirteen to eighteen inches, and when the boat subsequently came into my hands, as before noticed, showed evident effects of this pressure upon its form. A faster and more modern boat, however, was soon required in her place; and a new one was constructed, called the *New England;* and the managers, in the face of repeated warnings of the comparative weakness and insecurity of copper, felt bound again to conform to public sentiment, and accordingly furnished their new boat with copper boilers. These were of the ordinary thickness, constructed with two fire-arches in each boiler, together with five return-flues of circular form, and sixteen inches in diameter. These boilers, had they been of iron (which was then used in nearly all other boats), would probably have sustained any pressure that was likely to be required in the use of a modern expansive engine of ten

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* On board the steamboat William Gibbons, on the 21st of January, 1836; which is the last steam accident which has occurred to the boats running from New York.

It may here be remarked, that no reliance for strength should ever be placed upon the circular form of the boiler-metal, when the pressure bears upon the *outside* of the curve; except when its diameter is less than 24 or 18 inches; and in *no case* where the metal is exposed to heat, above or near the water-line, as in the "steam chimneys."

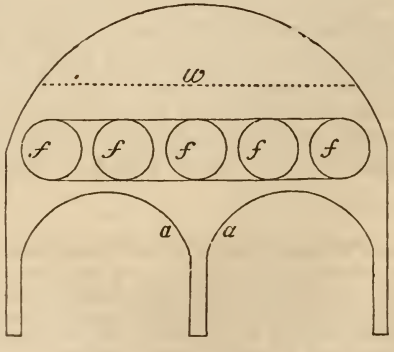
feet stroke; but the strength assumed or estimated for these copper-boilers by the manufacturers, unfortunately, was nearly if not quite as great as iron of the same thickness could have borne. On the 9th of October, 1832, which was soon after this boat commenced running, her boilers were both exploded, with a pressure of twenty-eight or thirty inches, while landing passengers at Essex, on Connecticut river, and about twenty lives were lost on this occasion.

The influence of the press in favor of copper, as may have been seen, had been generally overruled by practical men; and the effect of this disaster was such as nearly to put an end to the use of copper in this part of the country. But some of the conductors of the press who had been most active in establishing the untoward influence by which the owners of this boat had been governed, were now loudest in their denunciations; and men of the highest integrity and benevolence, who had perhaps exceeded all others in their well-meant efforts and sacrifices in order to ensure safety, were held up to public odium as being, virtually, the murderers of their fellow-citizens.

The proprietors of the New England, subsequently to the ordinary judicial inquiries, instituted a thorough investigation of the causes which led to this fatal explosion. They procured the attendance of a board of examiners, comprised of persons from different parts of the country, deemed competent to the investigation; and every facility was afforded for the most full examination and inquiry that the case admitted. The result of this examination, as given in the report of the board, has been already published; but its importance, as connected with the history of steamboat explosions, and its bearing on the future safety of steamboats, induces me to annex a copy of the same to this communication; and which is herewith respectfully submitted.

I will, however, add here, for the benefit of those who may not have opportunity to examine this report in full, a summary of the facts in evidence, and of the results to which the examiners arrived.

This boat had been running but little more than a month, and was fitted with two boilers, each about 8 or 8½ feet in diameter and 16 feet in length, placed on the guards behind the paddle-wheels and outside of the hull of the boat. Their construction may be understood from the annexed figure, which represents a cross-section of the boiler, near where the disruption first took place.



a, *a*, lower flues for arches; *f*, *f*, *f*, *f*, *f*, return flues; *w*, water-line.

The shell of the boiler was torn open in the lower arches, and spread outward till its parts met in an inversed position, and was thrown some distance from the boat. The flues and steam-chimney were uninjured by marks of heat or otherwise, and those of one boiler were thrown forward against the paddle-wheel cover, while the other was thrown over the same into the river. The parts of the deck or guards lying beneath the boilers, including the beams, were entirely blown off. This effect, which was directly beneath the apparent origin of the fracture, when taken in connexion with the direction in which the parts of the boilers were thrown, appeared to indicate that the disruption commenced in the lower flues or arches, at the places which had shown indications of straining, or leaks, on previous passages (near the points *a a*), and which had already received repairs. The engine remained uninjured, but the steam-pipe of the boiler which first exploded, was found broken entirely off from its fellow, at the point of junction in the engine-room, by the force of the explosion.* The safety-valve was attached to the main steam-pipe in the engine-room, near its junction from the two boilers, and was found in good order. A mercurial gauge, which was affixed at the same place had not discharged its mercury, and two similar gauges were attached near the boilers, in one of which the mercury was also found. These gauges had been so charged as to sustain a maximum pressure of about 32 pounds to the square inch! The pressure at the time of the explosion was, therefore, *below* this point.

The copper of these boilers was rolled to the thickness of Nos. 3 and 4 of the wire gauge, or one-fourth of an inch nearly. No marks of heat, or of the absence of water, could be discovered on the flues or on the flat work connected with their upper extremities, where a deficiency in the supply of water would first have exposed the metal, and where, in such case, injury or fracture could not fail to have resulted, with even a lower pressure of steam than was known to be on the boilers at the time of the explosion. In short, every appearance on those parts of the boilers which were exposed to heat, appeared to indicate that a full supply of water had been maintained. The weakest portions of the lower arches appeared inadequate to sustain a pressure of thirty pounds to the square inch. It came out in the testimony that the maximum working pressure in these boilers had commonly been from fourteen to seventeen pounds; that, immediately previous to the explosion, it had accumulated, from stoppages of the boat, *to over twenty-eight pounds!* And furthermore, that the engineers and firemen had been led to believe, by the manufacturers, that these boilers would sustain a pressure of even fifty pounds to the inch!—

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* This fact deserves special notice; chiefly, because the explosion of the two boilers of the New England at nearly the same moment has been gravely brought forward as proving the disaster to have resulted from want of water! But the boilers were alike in their structure, and both subjected, by the connexion of their steam-pipes, to an equality of pressure; and, being charged to the limit of their strength, it is not seen why both should not give way, especially under so powerful a shock, in addition to the pressure, as was necessary to separate the steam-pipes; which blow must alone have been equal to the weight of many tons. On the other hand, the boilers were supplied from separate pumps and pipes, and were a deficiency of water found in one boiler, it could have no connexion with the state of water in the other. It is on such shallow grounds that hypotheses and opinions are defended which appear to have a direct tendency to perpetuate these disasters. It was under the delusive notion of *security in a full supply of water* that these boilers were exploded.

an opinion which there is no doubt was honestly entertained by the latter.

The testimony obtained in this case was full and satisfactory. The engineers were both saved, and gave a detailed account of their proceedings previous to the disaster. The principal engineer had himself examined the state of the water in the boilers, a few minutes previous to the explosion, and there appeared to have been great care used on this point, as constituting the only source of danger. He states that the boat was stopped about two minutes at Essex, before the disaster, and he admits that he had more steam on the boilers than it was proper to use in the river, owing to the delays which had attended the progress of the boat. The engineers having full confidence in the supposed strength of the boilers, and knowing that the supply of water was complete, do not appear to have attended closely to the indications of pressure, which was, however, most accurately observed by the two firemen who were then on duty.

The pilot, who appeared a very cautious man, testified, that, after entering the river, he was obliged frequently to order the steam shut off from the engine, because he found it difficult to steer, while under full way. The steam was not blown off at Essex, except as it found its way through the safety-valve; which was loaded nominally to twenty-four pounds to the inch!—although here was also a liability to error.

The most satisfactory witnesses were the two firemen, who were both saved, after having been blown into the river. They had seen but little service, but their honesty and integrity appeared altogether unquestionable. From the clear and full details of their testimony, it appeared that the pressure on the boilers at this time must have exceeded twenty-eight inches (pounds) by the mercurial gauges! During the short stop at Essex, they had both tried the water in the several boilers, and found it at the highest try-cock, of which there were four in each boiler. One fireman then crossed to the other boiler, and after renewing the trial of water there, also, they entered into conversation on these circumstances, and on the little need which there appeared for any further firing to maintain a supply of steam. They had never seen the float-rods in the mercurial gauges so high as at this time. It was proven by measurement, that at a rise of thirty inches (thirty pounds pressure), these rods would strike the upper deck; and they testified that the rods were within three or four inches of the deck when the steamboat arrived at Essex. Other witnesses confirmed these statements, and that the pressure had not been so great on any previous occasion.

The larboard boiler, which had shown the greatest symptoms of straining, and received most of the previous repairs, exploded a little before the other, but the second instantly followed it; owing, probably, to the tremendous shock communicated through the steam-pipes, and by which they were broken asunder; while the boilers, being alike in their structure, were both charged to the limit of their strength.

In summing the results of their examination, the board reviewed the principal conjectures or hypotheses which had been urged by manufacturers and others, in order to account for this disaster, and pointed out their inapplicability to the case before them. They then came unanimously to the conclusion, *that the explosion was caused by an excess of steam, produced in the ordinary manner.*

In this age, distinguished for experimental knowledge and exact science, it might have been expected that the facts of the above case would have been patiently sought, and considered with attention, especially by professed teachers in physical science, and by those who are directly interested or employed in steam navigation. But notwithstanding our boasted attachment to the inductive philosophy, we find too often, that opinions and hypotheses on questions of pure physics, are cherished and defended with a pertinacity which is proportioned to their incertitude and lack of evidence; for in these cases the imagination has fuller scope for the defence of its own creations. In view of the facts which have passed under our notice, it is matter for regret that engineers of long practice, as well as some men of authority in science, should have lent their aid, without due inquiry, in support of prevalent errors.

Remedies for explosions, in order to be effectual, must be derived from a correct knowledge of the facts which serve to indicate their proximate causes. It appears remarkable, therefore, that this inquiry, instituted by the owners of the New England, should be almost the only attempt at careful and thorough investigation, for the benefit of the profession and of the public, which has yet been made in our country.

It was not reasonable to expect that the report of the above examination, although supported by the clearest evidence, would convince those who had long cherished some favorite theory concerning explosions: but the comparative safety which has since attended the numerous and rapidly increasing steamboats in this section of country, may induce the inference that a real advance has been made in exploring the cause of the evil and providing its proper remedy. As within the last few years explosions are almost unknown in the New York waters, may it not be inferred also, that the most effectual remedy within the power of Congress, is to provide for a thorough and free investigation of all such accidents and their causes, by persons competent to this duty, without reference to judicial measures; and for the proper publication of the facts, evidence, and conclusions, which may be arrived at in each case. This could not fail to afford us light on this important subject, such as would be available both to professional men and the public at large. We should then no longer grope in darkness, and our future experience would determine the question, whether persons who happen to be engaged in steam navigation are actually possessed by a species of monomania or indiscretion, which induces them wantonly to sacrifice their own lives and property, and those also of their nearest friends and fellow-citizens.

If we may rely upon the indications afforded in the above cases by the state of the metal in the exploded boilers—the most conclusive, perhaps, of all evidence, it will appear that the most common cause of these accidents, in this quarter, at least, has been the general use of boilers of insufficient strength, which have been worked under a pressure which has proved beyond the power of the boiler *permanently* to sustain. The *tenacity* of the boiler-metal is in great measure unavailing in resisting the external pressure to which the interior portions of the boiler are subjected; and reliance must here be had chiefly upon its rigidity, which is increased in a high ratio to the reduction of the diameters. The iron boilers which have been constructed on the general plan of those of the New England, at later periods, are more strongly braced, and, in addition to the advantages of a more rigid metal, have four arches instead of two, which

greatly increases their security; although a further advance in the strength of these structures is still desirable, especially in the part called the steam-chimney.

There is some reason to believe that the prejudice in favor of copper, as a material for boilers, was not eradicated from our southern cities by the experience had on the New York waters; and that the ill-fated Pulaski, which was lost in 1838, by the explosion of her boiler at sea, was projected under this disastrous influence. That it was the design of her owners to attain the greatest degree of security, cannot well be doubted; but the accounts which I have received of the methods adopted in the construction and the security of her boilers, afford grounds to infer that their actual strength was but little if at all superior to those of the New England; and I am also informed, that they had on some occasions, been worked with a pressure of 36 inches, and it is confidently stated that the gauge was seen at 28 inches on the night of the explosion; a practice which, if truly reported, must have arisen from the general confidence of all concerned in the adequate strength of the boilers. But the deplorable event has proved that this confidence in the supposed superiority and strength of these copper boilers had no just foundation; and the only matter for surprise, in view of such a state of facts, is, that an explosion did not sooner occur. Had the boilers been of iron, and of the same construction, it is probable that a regular working pressure could not have been obtained of sufficient intensity to have been immediately dangerous, for nearly double the amount of pressure would have then been required to produce the disruption.

Shipwreck of the Home.

This subject demands our present notice only on account of the influence it may be supposed to have had upon the recent legislation of Congress in imposing a system of inspection and fees upon the hulls of steamboats. Those who are fully conversant with all the facts of the case, need not to be told of the absurdity of the current statements regarding the loss of this ill-fated vessel, though countenanced by the exparte inquiry and report of a popular committee composed of clergymen and others, not professionally conversant with the matter before them, and gotten up under the greatest possible extreme of misapprehension, excitement, and error.

It may not be generally known that this vessel was constructed by some of our most able shipwrights, in a manner not visibly inferior to our best packet-ships, so far as may be inferred from casual inspections while building. That there were some special faults in this vessel, I believe; the chief of which, I conceive to be a want of greater depth of hold, which her length seemed to require. But the chief cause why she was strained more than the other steamers which have navigated our coast, was probably owing to her *greater weight;* being, if I mistake not, heavier built than most of her competitors. From the evidence before us, I feel bound to consider the *catastrophe* of the Home as occasioned by her being voluntarily run on shore in the breakers, chiefly through the influence of the alarmed passengers, who were apprehensive of foundering. Immediately previous to this act, the vessel, though partially water-logged, was under the land, and the gale was abating; and had she then been brought to anchor, as was the South Carolina, in similar circumstances, on the

same night, it is probable that she would not have sunk, and that no lives would have been lost. But, however this might have been, this case of shipwreck, and the subsequent catastrophe of the Pulaski, seemed to have had an extraordinary influence in procuring the adoption of the scheme of legislative remedies.

It may be justly questioned, however, whether the existing system of naval construction as practised in this and other countries, be not radically defective. In all the heavy shocks and strains to which a seavessel, and especially a sea-going steamer, is necessarily exposed, the ultimate strength of the whole structure consists only in the lateral resistance which is afforded by the fastenings and their bearing surfaces. Now it is both obvious and demonstrable, that this resistance is equal to only a very small portion of the strength of the timber and materials employed in construction, and is quite unsuited to the intensely severe strains to which these floating structures are sometimes exposed.

The remedy which suggests itself consists *in the mutual interlocking of all portions of the structure which lie in contact with each other.* In adopting this method, we relieve the fastenings from the great lateral strains by which they are injured and loosened in their bearings; and the resistance is transferred to the general mass of woody material which is employed in construction, where it is productive of no injury, the fastenings being thus relieved from all other duty than holding the parts in their proper places. The superiority of this method of construction, as compared with the pegging system, ordinarily practised, and in which reliance is only had upon the lateral resistance of the wooden and metallic fastenings, is too obvious to require elucidation. A freighting vessel of 350 tons, on the Hudson, in the construction of which I have put this interlocking system in practice, is believed to exceed in comparative strength and promise of durability, any other vessel now afloat. I consider this system of construction to be of essential importance, especially in a steamer which is to encounter the boisterous waves of the Atlantic.

Theories of Explosion.

The theories or hypotheses by which explosions are commonly accounted for, usually without proper examination and on the most vague and uncertain evidence, are chiefly the following:

1st. Injury to the boiler from heat, owing to a supposed deficiency of water.

2d. A sudden generation of steam by the affusion of water upon portions of a boiler thus heated.

3d. The supposed generation of violently explosive gases which are let off in the boiler.

4th. Recklessness on the part of those in charge.

5th. Ignorance of their proper duties in the same persons.

6th. Intoxication.

To which should probably be added, as more influential than all these,

7th. Insufficient strength in the boiler for the duties permanently required of it: owing to which cause the defects of the material, insidious fractures, or deficiency in water, have become destructive; either with common or an extra degree of pressure.

It is probable that the first two of these alleged causes have contributed to the explosion of high pressure boilers; and the deficiency of water is always to be considered as a source of danger and of certain injury to the boiler. Moreover, the greatest care on this, and other points connected with the management of boilers, cannot be too strongly inculcated upon those in charge. But it is well known that iron boilers have in *many cases*, been injured by a deficiency of water, under the very circumstances which are alleged as producing the most violent explosions, and that no other ill consequence has ensued than the injury to the metal. In the absence of all direct evidence, therefore, it is neither wise nor prudent, to throw the odium or responsibility of these accidents, which, it is probable, have mainly resulted from the general faults of the system, upon those persons who have too often perished while performing their executive duties according to their best knowledge and skill.

The theory which supposes the rapid generation of some yet undetected and highly explosive compound, is not worthy of consideration, having no other known support than may be found in a speculative fancy.

Ignorance of incumbent duties and recklessness of conduct, though sometimes found among all classes, are qualities which are not likely to obtain preference from the owners of steamboats, whose fortunes or success in business are mainly dependant upon the correct and intelligent performance of duty on the part of their agents and subordinates. In callings which are open to all classes, the only complete remedy for ignorance must be found in a more general and thorough system of popular education.

Persons who are in the habit of resorting to drugs or stimulants to keep up their vital energies, or for the gratification of a morbid appetite, are unfitted, generally, for so responsible a service as that of our steamvessels, and should never be employed, except in cases of sheer necessity. But in this species of misconduct, as in other cases, the securities afforded in construction should be such as to prevent the consequences of this vice from becoming fatal.

The notion that boilers, under the pressure of steam generated in the ordinary way, never burst, but only rend, has no foundation in truth, and has been sufficiently refuted on various occasions.

Steamboat Racing.

This subject appears to have attained an importance in public estimation to which it has no just claims. That there have been instances of misconduct attending these competitions, I have myself witnessed; and such instances are, doubtless, somewhat common. But that they are usually instrumental in putting in jeopardy the lives of passengers, is chiefly a bugbear of the imagination, which has been fostered by the public press till it passes on all occasions for reality. It does not appear to be generally understood, that the boilers of steamboats, if properly constructed, and particularly of those boats which carry large engines and work their steam expansively, are utterly incapable of generating a sufficient supply of steam to endanger the safety of the boiler while the engine is employed. The whole combination of parts in a properly-constructed steamvessel is such as to allow, if not require, all the heat which can be applied to the boiler, with no other check than is afforded by considerations of economy; and

the engine is competent to receive and work, with entire impunity to the boiler, all the steam which can by any means be thus generated. The entire structure is expressly designed for the attainment of the greatest possible degree of speed; and while this is aimed at, under the general restriction before mentioned, the parties in charge are only laboring in their proper vocation; provided always, that their conduct in other respects is judicious and proper, and that the vessel be navigating in smooth water of sufficient depth.

Of the various disasters of our steam navigation, I can recollect but a single case in which the explosion of a boiler could reasonable be referred to racing; and even in this case, it is probable that the disaster only occurred a few days or weeks *sooner* than it might otherwise have done.* I would by no means become the apologist of misconduct in this or any other matter; but it is time that the indiscriminate and sickly outcry which is so often raised on this subject should cease; for it is obvious that it can answer no other purpose than to increase the discomfort and terrors of weak and uninformed persons, or to furnish the occasion for a proscriptive paragraph in a public journal. The public have a real interest in the personal comfort and rapidity of steam navigation, which ought not to be trifled with in a senseless manner. These remarks are particularly applicable to the state of steam navigation in this quarter of the Union.

Every calling and pursuit in life is a race. The politician, the jurist, the artisan, and the mariner, all justly aim to accomplish the greatest ends in the shortest period. Why are not the enterprising commanders of our packet-ships arraigned before the bar of the public or subjected to penal enactments by Congress, for the unprecedented zeal and success with which, in late years, they have driven their ships through the waves of the Atlantic, in the face of dangers and of storms? Plainly, because those who have but little knowledge of seamanship do not attempt to control its operations.

Comparative hazard of steam in navigation.

So alarming have been the accidents in steam navigation on our western rivers and elsewhere, as to induce a belief in the minds of some that of all modes of conveyance this is the most hazardous. That a degree of danger has attended this mode of travelling, which ought to be lessened or avoided, it were vain to deny; but when we reflect on the recent origin of the art, and the vast numbers of persons who are transported by its means, and when we also consider the exposure and comparative accidents of other modes of navigation and means of conveyance, this impression will be materially altered, and we shall rather have cause to wonder that, under all the circumstances of the case, so small a fraction of the travelling public have become victims to this hazard. We have, indeed, a fearful list of steamboat explosions; but the sufferings and fatalities which have attended other modes of transport and conveyance, pass off with but little notice, as common occurrences, and their statistics are seldom known. Consequently, the public mind does not become excited in contemplating these casualties, which are treated only as evils which are incident to the common lot of man.

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* I refer to a case on the river Ohio.

By the report of a select committee of Parliament in 1836,* it appeared that the number of English vessels lost, in a period of three years (1816–'18), as collected from the books at Lloyd's, was 1,203; and in a subsequent period of like duration (1833–'35), was 1,702. That the number of persons distinctly known to have been drowned by these vessels in the firstnamed period, was 1,700, and in the second period, 1,714.

That during a period of 16 months, ending May 1, 1834, the loss of property by vessels reported in Lloyd's books as missing or lost, was estimated at 760,000 pounds sterling; and the loss of lives in the same vessels was estimated at 1,425. *These returns embrace only the losses entered at Lloyd's*, and by no means embrace the whole losses of British shipping.

It appears, also, that the *whole* loss of property in British vessels by shipwreck or foundering, is estimated at £3,000,000 sterling, annually; and the annual loss of life at sea at not less than 1,000 persons, not including the numerous losses of life on their own coast.

As regards our own navigation, which is inferior only to that of England, we find the following notice:

"*Shipwrecks in the year* 1837.—During the year past, there has been published in the Sailor's Magazine, a monthly list of shipwrecks which have occurred, principally of American vessels, and which have been published from time to time in various newspapers. Those only have been selected which resulted in a total loss of the vessel. The number of vessels thus reported during the year is as follows: ninety-four ships and barks, one hundred and thirty-five brigs, two hundred and thirty-four schooners, twelve sloops, and fifteen steamboats; making a total of four hundred and ninety-three vessels which have been wrecked. Of these, forty-three were lost toward the close of the previous year, though the account was not published till the commencement of this; thirty-eight were lost in the month of January, fifty-four in February, twenty-four in March, thirty in April, nineteen in May, fifteen in June, forty-two in July, fifty in August, thirty-two in September, forty-three in October, forty-three in November, and six in December. The precise time when the remaining vessels were lost could not be satisfactorily ascertained.

"In the abovenamed vessels, one thousand two hundred and ninety-five lives are reported as being lost. This, probably, is but a part of the whole; for, in many instances, the crew are spoken of as missing, and in other cases nothing is said, where, perhaps, there was a total loss." *Sailor's Magazine.*

This statement is said to comprise no deaths by steamboats, except in cases where the vessel was totally lost. On the other hand, a very large proportion of the fatal accidents in ordinary navigation must have escaped the knowledge of the inquirer.

Now, in view of this immense waste of life, let it be well considered that in the art and practice of navigation other than by steam, the world has had the experience of more than four thousand years, and the efforts and intellect of many generations have been tasked for its greater security; while, on the other hand, *a quarter of a century has scarcely elapsed* since the powers of steam became prominently known in navigation, and we have as yet only witnessed the brief *infancy* of its application to this

* See London Nautical Magazine.

important purpose. Surely, then, it is not surprising that disastrous and fatal accidents should sometimes have attended its use. There is cause for astonishment, rather, that so great a degree of average security should have been attained in so brief a period.

Each great district of our widely-extended country possesses its own peculiar facilities and hazards in this species of navigation, and exhibits, also, different stages of improvement and security in the use of steam. In this quarter, the average degree of security enjoyed by passengers in our steamboats is certainly greater than is possessed by persons who walk the streets of our large cities. During the last five years, *millions* of passengers have been carried on the steamboats which run from this city, and, among all these, the catalogue of deaths by steam explosions is almost inappreciable.

It is probably true that, in hardly any other circumstances in which such numbers have been placed, has the occurrence of mortality been so entirely wanting. It is with a strong sense of injustice, therefore, that those who are engaged in this important and not always profitable avocation, have found themselves selected as the objects of special and seemingly invidious legislation.

We know that elsewhere the result has been different; and much undoubtedly remains to be accomplished, in perfecting this important art, so as to render it, both here and in all other portions of our country, as secure to the traveller as can be reasonably desired. But this is plainly a practical desideratum, which can only be attained by the continued exercise of the experience and professional skill of those who may be engaged in this important department of enterprise.

Supposed safety of English steamvessels.

Of the various errors and opinions which have been cherished in our country, through prejudice or want of information, there is none, perhaps, which threatens to be more immediately injurious to our commercial interests, than that which ascribes to English steamvessels an almost entire exemption from explosions and shipwreck. This error would have remained unnoticed by me, had it not appeared as one of those general impressions which have probably contributed to the recent legislation on steamboats. It does not appear to be generally known that the principles of construction, the arrangements for security, and the general combination of parts in the English engines of the present day, do not differ, in any essential degree, from those which were usually adopted in this quarter, previous to the year 1825; and that accidents of a serious and fatal character have not unfrequently attended the use of steam in Great Britain, both on land and in navigation.

It is a fact, also, which may not be generally known, that there has been a greater loss of life by the explosion of steamboat boilers, during the present year (1838), on the river Thames alone, than has occurred in all the numerous and crowded steamboats which have run to and from our principal commercial city during the last five years!* And notwithstand-

* I allude here to two successive explosions on board the steamer Victoria, which are mentioned in the subjoined lists, and by which more than a dozen persons lost their lives

ing the contrary impressions made on the public mind by the shipwreck of the Home, and the recent appearance of several of the largest and best English steamvessels in our waters, it is also true that fatal accidents and shipwrecks have not unfrequently attended the English steamvessels. As the steam accidents in England have excited but little attention in our country, I now add such accounts and notices of accidents or extraordinary hazards to English boilers and steamvessels, as happen, at this time, to be in my possession. The immediate causes which are assigned, in order to account for these accidents, without impugning the general system of construction practised in England, may be allowed to pass for what they are worth.

Notices of accidents and extraordinary hazards to English boilers and steamvessels.

1. *Loss of the Red Rover.*—In October, 1836, a correspondent of the Nautical Magazine notices "the lamentable accident of that fine steamer, the Red Rover," which appears to have sunk, in consequence of a collision with the steamer Magnet, near the Nore.—*Nautical Magazine, December*, 1836.

2. *Explosion of the Union, steamboat.*—Hull, June 7, 1837. This morning, at 6 o'clock, at the moment when the Union, steamboat, from hence, was about to sail for Gainsborough, owing to some neglect, the boiler burst; and the packet being loaded on deck with passengers (about 120), the mischief done and loss of life have been dreadful. Several bodies were carried over the pier into the Humber; a fishing smack picked up one body, and saw two floating down at a short distance, apparently bodies of females. One person was carried into the air the height of some sixty feet, and came down on the roof of Mr. Werterdale's mast manufactory, which is seventy to eighty yards from the place where the packet lay, and is a building forty feet high. The safety-valve was blown against the office of the York packet (a wooden shed), about one hundred yards from the spot, with such force as to destroy one side of it.—*Nautical Magazine, July*, 1837, p. 474.

It was in evidence in this case, that the water ran freely from the second gauge-tap, immediately previous to the explosion; that the proper weight was on the safety-valve, which was lifted a moment before, and found in perfect order; and that the boiler would bear ten pounds to the square inch, but was adjusted to work with $5\frac{1}{4}$ or $5\frac{1}{2}$ pounds. The boiler had been in use less than six months. The explosion of another boat, called the *Graham*, is also alluded to in the evidence.

3. *Foundering of the Apollo, steamvessel.*—About 4 o'clock, on the morning of the 5th September, 1837, the steamship Monarch, Bain, for Leith, and the steampacket Apollo, Minter, from Yarmouth for London, came in contact off Grays (Essex); the Apollo went down in ten minutes afterward, and the stewardess and two children were drowned.—*Shipping Gazette.*

4. *Loss of the Killarney, steamer.*—This steamvessel was wrecked, by stress of weather, on the 20th of January, 1838, on the coast of Ireland, on her passage from Cork to Bristol; and of 37 persons on board, 24 perished.—*See Nautical Magazine, March*, 1838, pp. 211 and 212.

5. *Fire on board the Ocean, steamship.*—Yesterday (Sunday) afternoon, between 1 and 2 o'clock, very great excitement was created on the river, and also ashore, among the shipowners, by a fire being discovered raging on board of the new and large steamship, the Ocean, Myddleton, of London, lying off the custom-house quay. The Ocean had just arrived from Calais with a most valuable and extensive cargo, consisting of merchandise and goods of all descriptions; there were a great many passengers on board, and they were landed at London-bridge wharf before the vessel was moored, with other steamers of the foreign station, off the custom-house. The flames were first seen raging among the larboard coal-bunkers, close to the furnaces, and by that period they must have been burning a considerable time. The engineers and firemen made every attempt to extinguish the fire, but, ultimately, by the overpowering influence of the smoke, they were forced upon deck. The greatest fears were now entertained for the safety of the vessel, as the fire had extended abaft the boilers, and communicated to the linings. Volumes of smoke were seen to issue from the engine-room and round the funnel, which rapidly increased, and the utmost confusion prevailed among those on board, and the vessels lying alongside. When an entrance into the engine-room could not be obtained, the deck, save that portion on fire, was torn up by pole-axes, and thereby access was found to the flames; the force-pumps were then got to work, and in about an hour the fire was completely subdued, to the gratification of those on board, and before so much damage was done as was at first, from the appearance of the flames, anticipated. There is no doubt, had the disaster taken place at midnight, the consequences would have presented a different appearance altogether. It is believed that it must have been from the excessive heat of the furnace, and not through the coals in the bunkers. The engines of the Ocean are of an extraordinary power, and the vessel is the property of the General Steam Navigation Company.—*English paper, September*, 1838.

6. *Disruption of the boiler of the William Stanley, steamer.*—Liverpool, August 21, 1838. Yesterday morning, about 11 o'clock, great consternation was caused at George's pierhead, by the supposed bursting of a boiler of the William Stanley, Eastham steamer, while lying alongside of the pier. But the truth appears to be, that the lower plate of the boiler gave way, previous to their firing up to leave the pier; and no accident was occasioned except the scalding of the legs of a lad who was employed on board.—*English paper.*

7. *Hazard of the Tweedside, steamer.*—North Shields, September 15, 1838. Intelligence reached here to-day of a very narrow escape from a melancholy disaster on board of the Tweedside, steamer, on her passage from Leith to this place. She left Leith early yesterday morning, and proceeded on until she came near to North Berwick, when it was discovered the steamer was on fire. Attempts were made for some time to extinguish the flames, but without effect. The alarm of the passengers was dreadful; when, fortunately, a London steamer came in sight, and various flags of distress were hoisted. The passengers were taken on board the latter vessel, and conveyed to Leith, where they were placed on board of the Northern Yacht, and arrived here to-day. The Tweedside was towed into Berwick, where she will receive the needful repairs. The passengers arrived here concur in stating that, but for the providential ap-

pearance of the London steamer, all on board would have perished.—*Shipping Gazette.*

8. *Fatal steam-boiler explosion.*—Another steam explosion, attended with loss of life, occurred at Halliwell, near Bolton, in this county, on Wednesday se'nnight, at the factory of Mr. W. G. Taylor, Hill-mill; and we regret to say that the consequence proved fatal to a young man named Thomas Halliwell, aged nearly nineteen, an engine-tender. The deceased had been four years assistant in the engine-house, and was a steady industrious workman. The boiler burst with a loud crash, destroying the engine-house in a moment, and burying the deceased amid the ruins. All hands were soon on the spot, and, after removing the bricks and the stones, the body of the unfortunate man was found quite lifeless; he was dreadfully scalded and disfigured, and presented a miserable aspect. Mr. Taylor's mill being furnished with an excellent waterwheel, steampower, we understand, is only used there occasionally. The boiler was in admirable condition, and the accident can be attributed to no other cause but an excess of steam, or a deficiency of water. An inquest was held the following day at the Lamb inn, Sharples, before W. S. Rutter, Esq., coroner. The jury was of opinion that the accident had been occasioned by overfiring, in consequence of the steam being low. The death of the deceased was quite accidental, and no blame could be attached to any party.—*English paper, September*, 1838.

9. *Dreadful steam-boiler explosion.*—Newton-in-the-Willows, Monday night, September, 1838. The viaduct foundry on the Manchester and Liverpool line of railway at this place, the property of Messrs. Jones, Turner, & Evans, was this morning, the scene of a dreadful and fatal steam-boiler explosion. Six persons are already dead, and four others are lying without the least hope of recovery. It appears that Messrs. Jones & Co. employ about 200 men, and in the course of their business use two steam-engines, one of 16-horse power and the other of 8, to drive the blast for the smiths' furnaces. Last week a new boiler was put to the 8-horse engine, and the foreman of the yard, Joseph Dangerfield, who superintended the erection of the boiler, resolved upon setting it in motion himself. It was tried on Saturday, and was then found to work well. This morning he was called by the watchman at 5 o'clock, and he immediately proceeded to light the fire and get the steam up in the boiler. He accomplished this task by 6 o'clock; at that hour the men came to work, and about ten or a dozen of them stood at the mouth of the furnace, anxiously waiting to witness the evolutions of the engines, which had been stopped for the purpose of attaching the straps communicating with the machinery of the foundry. This had been in part accomplished, when, all of a sudden, the steam and water burst through the flue of the boiler, and carried the contents of the furnace and part of the brickwork full 40 yards from the building. The explosion was terrific. The bystanders and Dangerfield were carried as if by a gun-shot into a field of corn on the outside of the foundry palings. The palings were knocked down, the corn levelled to the ground for full 20 yards' distance. Three of the men were picked up quite dead; their names are Joseph Dangerfield, Samuel Appleton, and George Fazakerley. John Dean was found on his knees praying to the Lord to have mercy on his soul; he lived until 10 o'clock. Thomas Price was picked up insensible; John Parker was dreadfully mutilated; William Wells, George Hough, William Dane,

and —— Wilson, were also taken up dreadfully scalded and bruised. They were quickly attended by some surgeons and a physician from Newton and St. Helans. George Hough and William Wells lived for a few hours only. Most of the sufferers are married men with large families.

A seventh sufferer died just as our informant was closing his report. His name is Price, the father of a large family.

No cause is assigned for the accident. The exterior of the boiler still remains perfect.—*English paper.*

10. *Extreme hazard of the Royal Tar, steamer.*—We reported in the *Shipping and Mercantile Gazette* of Saturday, that the Royal Tar, steamer, had put back to Falmouth; the following particulars we take from the *Courier:* It appears that the Royal Tar underwent some trifling repairs last voyage at Limehouse, and left the river on Friday the 12th instant, for Lisbon and Gibraltar. On reaching the Bay of Biscay she met a heavy sea and stiffish breeze, which strained her to that degree that she was half full of water before the captain and crew were aware of it. If there had not been six pumps to go to work, she must have gone down. There were 65 passengers on board; and when it was reported that the ship was sinking, the scene of dismay and uproar that ensued baffles description. A passenger writes as follows: "The company has got an exceedingly clever officer in Mr. Lewis, the commander of the Royal Tar; and to his presence of mind, in the first instance, and his determined conduct afterward, do we owe our lives, and the company the safety of their vessel." The passengers have landed at Falmouth, there to await the arrival of another steamer.*

11. *Great hazard of the Victoria, steamer.*—Liverpool, October 20, 1838. On Friday last, after beating out through Crosby channel, the crew of the pilot-boat No. 9 saw a steamvessel, with a signal of distress up, the ensign union down, and a whiff up forward at the fore-topmast head, appearing in great distress, and in want of the assistance of the pilot-boat. At this time (12½ o'clock) the vessel was a long way to leeward of the pilot-boat. The latter made all possible sail towards her, perceiving that she was drifting down on West Hoyle bank. At 2 o'clock they got to her, when she proved to be the Victoria, from Liverpool for Strangford; the captain hailed the master of the pilot-boat, saying that he had lost his rudder, that his pumps were choked, that all his passengers and crew were bailing with buckets to keep the vessel free, and that the water was gaining so fast as to put the engine-fires out. The master of the pilot-boat promptly rendered assistance, by getting two ropes from his stern, and endeavoring to steer him into safety. With difficulty the pilot-boat got hawsers from each quarter; but the sea running very heavy, with squalls, it parted both hawsers. The master advised the captain of the steamer, under this difficulty as she had no way through the water, and was quite unmanageable, and through the indefatigable exertions of himself and crew, an endeavor was made to replace the hawser, when a heavy sea struck the steamer, and hove her on board of the pilot-boat, which sustained considerable damage. From thirty to forty passengers jumped on board the pilot boat at the same moment, which placed the master and

* This disaster, resulting from the straining of the vessel, resembles that of the Home, previous to her being run on shore, except that the severity of the weather appears to have been far greater in the case of the Home.

crew in an awkward situation. The master advised the captain to allow No. 10 pilot-boat, which was in company, to have a hawser out from forward to tow ahead, as the night was coming on very fast. With great difficulty this was accomplished. The pilot-boat had not towed more than half an hour when a very heavy squall came on, and parted the best and newest hawser which the steamvessel had on board, and the same squall parted also one of the hawsers which No. 9 had out astern steering her; so that there was only one hawser left to steer her by, the only one on board the steamer. Fortunately, it held until they got into smooth water; and at 7, P. M., they came to anchor in safety near the north-east buoy. At the request of Captain Aberdeen, the pilot-boat No 9 came to anchor close astern of the vessel, where she remained until Saturday morning, when the steamer was towed in safety to the entrance of Clarence dock. Great praise is due to the masters and crews of the pilot-boats for their exertions on this occasion. Had it not been for their interference, the Victoria would have been inevitably lost. No. 9 pilot-boat sustained very considerable damage, and has been since undergoing repair.—*Liverpool Mail.*

12. *Upsetting of the Shamrock, steamer.*—Waterford, October 20, 1838. Thursday, as the Shamrock, steamer, was coming down the Ross river, the pigs on board went all to one side, and the steamer filled. The passengers landed safely, and the disabled vessel was towed up to Waterford by the Duncannon.—*Waterford Mirror.*

13. *Explosion of a steam-boiler upon the Tyne.*—On Sunday morning, the 2d instant, the Vivid steamboat, belonging to four brothers named Greener, of Shield, was engaged to tow some ships out to sea, and had got her steam up for that purpose, when the owners (who worked the boat) found that she was not in a fit state to do so. They accordingly brought her up, and, while two of the brothers were employed in raking out the fires, the boiler exploded with great violence, and dreadfully scalded two men who were below. They were immediately conveyed home, where they lingered for a few hours and then died. The deceased were men of excellent character, and much respected. One was a single man, but the other has left a wife and family to regret his loss. This accident appears to be the more singular as the boiler had been undergoing some repairs, and was only finished on Saturday. An inquest will be held by S. Reed, Esq., coroner, this day (Tuesday), at 3 o'clock. Several of the steamboats running between Newcastle and Shields are now in the habit of so much overlading their boilers, that, unless some check is put to the practice, we shall not be surprised at some dreadful accident occurring. Some person, who is competent to the duty, should look to this without delay. We are glad to hear that the Government have it in contemplation to appoint an officer for the express purpose of examining steamvessels, and of affording protection to the public.—*Tyne Mercury* (1838).

14. *Accident to the boiler of the Sirius.**—London, October 3, 1838. The Sirius, steamer, Ellis, reported yesterday as having sailed from her moorings, off East-lane stairs, for St. Petersburg, did not get farther than the Pool when an accident happened to one of her boilers. The damage can be repaired in two or three days, when she will proceed on her voyage.

15. *Steamer Northern Yacht foundered.*—It has been ascertained that

* This steamer had recently visited New York.

the steamboat Northern Yacht is lost. She was seen to sink, and all on board perished; twenty-three in number.—*English paper* (*October*, 1838).

16. *Steam-boiler explosion.*—Yesterday morning, just before 6 o'clock, the boiler of the steam-engine which moves the machinery in the wadding manufactory of Messrs. Richards & Taylor, of James-street, a short distance south of Kennington common, blew up with a loud noise, throwing the whole length of the engine-house into the street, and with such force as to knock down several yards of a wall on the opposite side of the way, a distance of fifty feet. Had the explosion occurred but five minutes later, when a number of persons would have collected in the street prior to their going in to their work, the consequences might have been fatal to many. The engine is of thirty-horse power, but the boiler is only capable of working to twenty-horse power. No cause can be assigned for the accident. Fortunately, no one was injured.—*English paper* (*August or September*, 1838).

17. *Sinking of the Hope, steamer.*—A towing steamer, named the Hope, of Shields, on entering the harbor, ran foul of a dredging-vessel which is used for cleaning the harbor. The steamer became very leaky, and sunk near the head of the pier. She has since become a total wreck. Crew and part of the materials saved.—*Sunderland* (*Eng.*), *October* 13, 1838.

18. *Disastrous and fatal accident.*—On the morning of Saturday se'nnight, the neighborhood of Upper Easton, near Bristol, was thrown into great alarm by the sudden explosion of a large steam-engine boiler on the premises of Messrs. Bayly & Co., lead-smelters. The effect was most terrific, and showed the immense power of steam. The boiler, which was nearly twelve feet high, and thirty-five feet in circumference, and which weighed between three and four tons, was literally carried through the roof of the building, over an adjoining workshop, into a field eighty yards distant, tearing down a stack of chimneys. The shower of rafters, bricks, tiles, and stones, which accompanied the explosion, was truly awful. The roads and fields close to the works were covered with the fallen fragments; and a broad-wheeled wagon, loaded with small coal (the whole weighing four tons), was thrown several yards and upset; the near hind wheel being struck off the axletree. We are sorry to say that six persons, including the engineer (who was supposed to have been feeding the fire at the time), were dreadfully scalded, and taken to the infirmary. Three of the sufferers have since died. From the inquest, held before J. Langley, Esq., coroner, it was found that the engineer, who has unfortunately perished, was the cause of the accident. He ignorantly overloaded the safety-valve, from some misconceived notion of trying the strength of the boiler after it had been newly repaired.—*January*, 1836.

19. *Burning of the Royal Tar.*—The British steamvessel Royal Tar, from St. John's (New Brunswick), bound to Portland, with one hundred passengers, in October, 1836, took fire, owing to some defect about the boilers, and was destroyed. Thirty persons lost their lives by this disaster.

20. *Disastrous shipwreck of the Rothsay Castle, steamer.*—The steamer Rothsay Castle, from Liverpool for Beaumaris, was lost, in the month of August, 1831, and a great number of persons perished.

A volume of 322 pages, relating to this disaster, is now before me.*

* Narrative of the Wreck of the Rothsay Castle, steampacket. By Joseph Adshead. London: Hamilton, Adams, & Co., 1834.

To a list of the persons on board, which it contains, the author appends the following statement: "This list presents the number of 141 individuals who are *known* to have been on board the Rothsay Castle at the period of her wreck; and if the moderate calculation be admitted that nine only were lost, of whom nothing has been heard, it will realize the estimate I have hazarded at page 289, namely: that 150 persons were on board, of which number *one hundred and twenty-seven perished!*"

21. *Dreadful shipwreck of the Forfarshire, steamer, from Hull to Dundee.—Thirty-five lives lost.*—One of the most dreadfully calamitous shipwrecks that has taken place on the coast of England—perhaps involving the greatest loss of life since the loss of the Rothsay Castle off the Isle of Anglesea—took place yesterday week, off the coast of Northumberland, when the steamvessel called the Forfarshire, on her voyage from Hull to Dundee, struck on the rocks of the Farn islands, and no less than thirty-five of the passengers and crew perished. This steamer, which was a fine large vessel of 400 tons burden, provided with two boilers, appears to have been lost owing to the bad state of her boilers: and although she was exposed to very rough weather, yet, as will be seen, her boilers must have been in a defective state when she quit the Humber.

The Forfarshire sailed from Hull for Dundee on Wednesday afternoon, the 5th instant, at 20 minutes past 6 o'clock, along with the Pegasus and Innisfail, for Leith. On Thursday morning, about 4 o'clock, the boiler became leaky, but it was partially repaired; and the steamer proceeded on her voyage, till she arrived at the mouth of the Frith of Forth, about 10 o'clock in the evening. It then blew a heavy gale from the northward. The boiler, it would appear, had now become useless, and the machinery stopped. The vessel was got about, in the hope to get her before the wind, but she soon became unmanageable. It rained heavily, accompanied by a violent gale, with a heavy sea, and the vessel drifted toward the Farn islands, on the outer one of which she struck about 3 o'clock on Friday morning. The captain (John Humble, late master of the Neptune, of Newcastle) did not, from the state of the weather, know where he was, nor was danger apprehended until breakers were discovered close under the lee of the vessel. As soon as the breakers were discovered, the steward went into the cabin to warn the passengers (who were in bed) of the danger. They rushed to the deck, which the most of them must have reached before the vessel struck; but as the steamer, almost instantly after striking, parted into two pieces, the whole of the cabin passengers, twenty-five in number (with one exception, who, with eight of the crew, got on board one of the boats), are understood to have met with a watery grave. Among the cabin passengers were several ladies. The crew consisted of twenty-two, ten of whom, and the captain, are drowned. Five steerage passengers and four of the crew were taken off the fore-part of the wreck, in the course of the morning, by a boat belonging to the light-house on the island. Thus it would appear that thirty-five persons have lost their lives. Only one cabin passenger, Mr. Ruthven Ritchie, Hill of Ruthven, Perthshire, was saved.—*Leeds Mercury, September* 15, 1838.

22. *Dreadful boiler explosion.*—In Woolhouse's edition of Tredgold, there is mentioned the explosion of a large English boiler of the old spherical form, twenty feet in diameter, in which the thickness of the plates

was from a quarter to half an inch; the load upon the safety-valve seven pounds per circular inch. Many lives were lost by this explosion; and the boiler was thrown to a distance of 150 feet, to a place thirty feet above the level of its former seat.—*Tredgold*, p. 251.

23. *Blowing up of the Earl Grey, steamer.*—On Friday evening, a few minutes before 6 o'clock, a dreadful accident took place, occasioned by the bursting of the boiler of the Earl Grey, steamer, while she was lying at the steamboat quay, on her way from Dunoon to Glasgow. The Earl Grey had been moored at the quay about fifteen minutes, and was just on the point of starting (the bell having been rung), when an explosion happened of so dreadful a nature, that the boiler was rent completely round, the roof forced up into a perpendicular position, the upper flues driven into the cabin, and the lower part of the boiler and under flues removed from their situation, blowing the deck completely off, from the funnel to within eight or nine feet of the stern. The unfortunate persons who were standing on that part of the deck were blown into the air; two of these fell upon the quay, both of whom died immediately after; the rest fell into the sea. The water from the boiler was thrown nearly to the west end of the steamboat quay, over the shed, on board two vessels, the Jean and the Rebecca; the rope which fastened the steamer's stern to the quay was blown on the top of the shed, also camp-stools, large pieces of wood, &c. A part of the boiler, six or eight feet square, was driven, by the force of the steam, a distance of one hundred feet and upward. A great number of persons standing on the quay were much injured by the scalding water, and by pieces of coal, wood, &c., falling on them.

By this melancholy event six persons have lost their lives, fourteen been severely injured, and twelve slightly (thirty-two, in all); but it is impossible at present to state the precise number of the sufferers by this dreadful occurrence, as it is believed that some of those thrown into the water have not been found. The steward says that before the accident he counted twenty-seven persons on the quarter-deck, and considers that there were about forty persons on board at the time of the explosion.

The steward of the Earl Grey, while standing on the paddle-box, was knocked overboard by a large piece of coal, but got out little injured. Excepting the steward and one seaman, who was killed, no other person connected with the vessel was hurt. A young lady, Miss Stevenson, had gone on board the vessel, accompanied by her sister and a young gentleman, a few minutes before the accident took place. The young man had gone forward to the bow, leaving the two young ladies standing abaft the funnel at the moment the explosion occurred. When the steam and smoke had cleared away, he discerned one of the Misses Stevensons in the water, at a considerable distance from the vessel; and, although an indifferent swimmer, he plunged overboard and saved her. The body of the other sister was got out of the water an hour and a half after the accident, by the boats which were employed in trauling, but no other body has yet been found.

Mr. Matthew King, of Port Glasgow, who was, with Mrs. King, blown overboard, saved himself by clinging to a block attached to a rope which hung over the vessel's side. While in this situation, he saw Mrs. King floating. He immediately got hold of her; and, while supporting himself with one hand, and holding his wife with the other, some person seized

hold of the rope Mr. King was clinging to, and nearly pulled it from his hand. Mr. King, with great difficulty, got him to desist until a boat came to their assistance, and rescued them just in time, as Mr. King had become completely exhausted.

Mr. Hugh Watson, who is mentioned among those killed, was on the deck at the time of the explosion; the force of which blew him and Angus Wilkie, who was loosing the stern-line at the moment, a great height into the air. They both fell on the quay; and the bruises they received from this, together with the effects of the steam and scalding water, caused almost instant death in both cases.

Mr. Peter Somerville, of Glasgow, one of the passengers, who saved himself by his singular activity and presence of mind, described to us, in the following manner, the circumstances connected with the blowing up of the vessel, as far as his own observations had extended: Mr. Somerville was surprised at perceiving the cabin to be full of steam, and, becoming apprehensive that something was wrong, he advanced to the farthest end, when a hissing noise which he heard convinced him that an explosion was about to take place, and he sprung suddenly out at one of the cabin windows, breaking the glass, a pane about fourteen inches square. Instantaneously as this was done, the explosion occurred before his legs were quite out of the window; and his feet were scalded by the hot water or steam rushing into the cabin. Fortunately, Mr. Somerville succeeded in catching hold of an iron rod projecting from the stern, by which he hung until the stern-boat had been lowered, when he was drawn up to the deck of the vessel. While thus hanging by the steamer's stern, Mr. Somerville looked down into the water, in which he thinks he observed about thirty persons, many of whom appeared to have been hurt by the explosion and were streaming with blood. He saw six or seven couples clinging to each other, as if resolved to be saved or lost together. On being hauled up the stern, Mr. Somerville found that the greater part of the deck had been torn up; on the only portion of which now remained, namely, a few feet of the stern, he observed an old gentleman evidently much hurt, and a lady, of apparently about forty years of age, who was either dead or had swooned. All the other cabin passengers appeared to have been blown off the deck by the violence of the explosion.

The quay at which the vessel was lying at the time of the accident was, in an incredibly short time, crowded by persons of all descriptions. The excitement was much increased by the wounded sufferers being borne along the streets to the infirmary, and various other places. The steamboat quay, about 7 o'clock, presented a scene of horror happily never before witnessed here: mangled and bleeding bodies carried to the places where aid could be administered; the boats employed in trauling for the bodies rowing backward and forward, anxiously watched by the spectators whenever the men aboard hauled up the creepers, to which, in almost every case, were hanging pieces of clothes, shirts, handkerchiefs, &c. But the most fearful spectacle of all was the vessel herself—the roof of the ponderous boiler poised in mid-air, over which the funnel lay crushed and broken; the uptorn decks exposing the cabin, into which the upper flues of the boiler had forced their way; while hats, and portions of male and female attire, were strewed around, telling too truly of the fearful destruction that had taken place. It may be consoling to the friends of those who were injured to know that every thing which humanity and skill

could devise was done to alleviate the agonies of the unhappy sufferers.—*Greenock Intelligencer, July*, 1835.

24. *Explosion on board the Victoria, steamer.*—On the 14th of June (1838) a dreadful accident happened in the river, by the explosion of a boiler on board the Victoria, Hull steamship, by which nine unfortunate men lost their lives.—*Shipping Gazette.*

This explosion, and another which also occurred on the Thames a few months previously on board the same vessel, by which several lives were lost, have already been alluded to.

There are other cases of like character before me, of earlier date, which I omit to notice; but the above are sufficient to show that these accidents are not confined to American steamboats, but often occur with low-pressure engines under the English practice.

The various hazards and casualties here enumerated serve not only to show that the hazards which have hitherto attended the use of steam are not confined to our own country, but that the use of steam of only five or seven pounds pressure to the inch, with a dependance on nicely adjusted safety-valves and other apparatus, will not ensure safety; and that the latter must be sought in the surplus strength of the boilers employed.

Of the foregoing cases of the shipwreck of English steamers, it may be remarked, that a large portion of those which were most disastrous could probably have been avoided had their engines possessed equal efficiency with those which are used in the New York steamboats.

Steamboat legislation.—The subject of legislative enactments for promoting the security of passengers in steamboats, has often been a matter of discussion since the latter were first introduced in our country. But, till recently, there has appeared an evident reluctance to legislate on subjects relating to the arts and occupations of particular professions; such interference being generally considered as ungenial to the character of our institutions, and contrary to sound policy. The objections to legislative interference were peculiarly strong in the case before us, owing to the infancy and importance of the art in question; the professional knowledge and experience which were required to regulate it with success; and the difficulty, not to say impracticability, of devising a system of legislation which should be adapted to all the diversified circumstances of this great country, and to the rapidly improving state of the art itself.

There is, however, but a small fraction of the people of the United States who are directly concerned in steam navigation, and the unhappy disasters which have attended it have presented to our contemplation dangers of a new and appalling character, and have occasioned ceaseless efforts for the accomplishment of such legislation as should, in reality or appearance, offer security to those persons who, under the lively impression of danger, could discover little else than incompetency, treachery, or suicidal depravity, in those who conducted the operations of this new and powerful element of locomotion. A few in the profession itself, being impatient, perhaps, of the opposition offered to their views, or of the continued existence of evils and defects, which to them appeared susceptible of a prescribed remedy, have joined in recommending the interference of the National Legislature. It remains to be seen whether this interference is to be productive of more good than evil. That it has signally failed in preventing the recurrence of the calamities which have been deprecated, is too apparent in the recent explosion of two steamboats on the Missis-

sippi, which were fresh from under the legal inspection, and which have been attended with a fearful destruction of life.* It is much to be apprehended, therefore, that these enactments can serve no better purpose than to relieve the owners and managers of steamboats, in a measure, from that weighty sense of responsibility to the public under which they have hitherto labored, irrespective of their private interest in the safe and prosperous conducting of their business.

But aside from the more than questionable policy of some of the enactments of the statute in question, there is one provision, adopted without notice, and apparently, without premeditation, which appears to be a reversal of the principles which have hitherto prevailed in our system of legislation and jurisprudence—a provision which appears as injurious and unjust in its implications of a most useful, worthy, and patriotic class of our fellow-citizens, as is the misapprehension of fact and of character, on which it would appear to have been founded. I shall be understood as alluding here to that provision of the late law of Congress which assumes the owners of steamboats to be guilty of misconduct and liable for all injuries or losses, in cases of injury or explosion by steam, unless they may be able to produce satisfactory evidence to the contrary—a task which, with the purest conduct and intentions on their part, might often be rendered impossible. It is sincerely desired that such a provision may not long be found in our statutes. The common law of the country is sufficiently relentless and severe in all cases of implied criminality, or even of negligence; and a resort to the enactment in question would seem justifiable only in relation to a class of persons who were universally and odiously criminal, instead of a class who, in every thing which constitutes private worth and good citizenship, are probably not inferior to most others in our country.

The owners and constructors of steamvessels have not been examined or consulted by the committees which have been charged with the preparation of the late law. Nor have those persons intruded their private opinions and views upon Congress, nor upon the public. Still less have they been disposed to place themselves in the attitude of defendants, on groundless and absurd allegations; or even to plead the great benefits which they have rendered, or the sacrifices which they have made, while engaged in advancing one of the most important interests of the public lic and of the civilized world. While the state of the country, its society, its business, and enjoyments, have been so rapidly improved or changed by their operations as to excite the wonder not only of an admiring world, but even of ourselves, these persons have been content to labor, through good and evil report, as willing instruments in the rapid advancement of their country in its industry, knowledge, and power. Well might they have anticipated any other notice from the supreme power of their country, rather than the apparently ungracious rebuke which seems to be implied in the above enactment.

The pecuniary sacrifices which have been made by the owners of steamboats, while thus advancing their country's best interests, have been great

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* Other deplorable accidents have since been added to the catalogue; and these renewed disasters may serve to show, first, that the remedy does not lie within the reach of the legislature; and, second, that our western friends *must* relinquish their ultra system of high-pressure, which has so long been cherished on their waters.

almost beyond example. It was estimated, some five years since, that the amounts which had then been lost by the owners of steamboats which have navigated the Hudson, this queen of rivers, were sufficient to have constructed a good railroad between the cities of New York and Albany; and there is reason to believe that the losses have been at least proportionate in other sections of our country. Surely, it might have been expected that this interest, above all others, would have been deemed worthy of the countenance and protection of our National Legislature.

In a reply to the inquiries of the honorable Louis McLane, Secretary of the Treasury, dated December 23, 1831 (which appears as No. 3, in document No. 478 of the House of Representatives, 1st session of the 22d Congress), I have cursorily noticed some of the points which are herein referred to. To this communication, and especially its concluding remarks, I beg leave now to refer.

Of the regulations for preventing collisions in navigation, those which are found in the laws of the State of New York are, in my view, of far greater practical value than those which are found in the late act of Congress.

Among those persons who control the forms and modes of construction of steam-boilers and engines, there is found much variety of opinion and practice, which necessarily occasions different degrees of excellence or defectiveness. To unite, at once, these various views in the most perfectly approximate system of security and efficiency, by the operation of a blind external power, is quite impracticable. It is only by extensive practice and patient observation that so desirable a result can be reasonably expected; and *time* is essential to its attainment. It is not unreasonable to expect that the period is rapidly approaching in which American steamboats will as far exceed those of other countries in safety from explosions, as they now do in practical efficiency, and in skilful adaptation to the purposes for which they are specifically designed.

Prevention of explosions.—In adopting rules of construction for boilers, it should be considered that iron is liable to be permanently affected by a force which is equal to only one-third of that which is necessary to produce immediate fracture. The point of maximum pressure, therefore, at which the steam-gauges should be adjusted, so as to blow off their mercury, should never exceed one-third of this subordinate force. In other words, the highest pressure of steam allowed, under any circumstances, should not exceed *one-ninth* of the force, which may be fairly estimated as necessary to break or immediately injure the boiler, instead of being equal to only one-third or one-half of this force, as is recommended in Woodhouse's edition of Tredgold,* and, as I am informed, is usually practised in England.

Experiments, if deemed necessary, might be made upon boilers of the different forms of construction which are commonly brought into use; and these experiments, together with the estimated tenacity and stiffness of the metal employed, would serve for a basis in estimating the strength of any boilers, and the actual proof be thus avoided; for, a proof of high tension may, by its incipient effects, tend to produce, ultimately, the very disasters which it was intended to prevent.

Much has been said and written on the means of preventing explosions; and if the efficacy of the various preventives which have been proposed,

*Tredgold, part i., pp. 249 250. London: 1838.

had only been equal to the zeal and confidence with which they have been sometimes urged, we should have little occasion for pursuing the inquiry.

Of the experimental investigations which have been made, unconnected with working practice, none have a higher claim to consideration than those made at Philadelphia by a committee of the Franklin Institute; and the elaborate report of this committee must be considered as a document of high value and great practical utility. The report of the committee of the American Institute of this city, on the explosion of steam-boilers, is also a well-reasoned production, indicating a thorough knowledge of the subject on the part of the committee; although I cannot accord to the implied conclusion, that the use of steam of more than seven pounds pressure to the inch must, necessarily, be considered as dangerous.*

Notwithstanding all which has been said and done on the subject of nicely-adjusted safety-valves and other apparatus, explosions still continue to occur; and so long as boilers continue to be subject to insidious and unknown defects, and the limit of their strength is found to be too nearly that of the working pressure, they cannot be expected to cease. The safety-valve, and the mercurial gauge, as now used, are perfect instruments of their kind, and have all the adaptation that can reasonable be desired for showing the actual pressure, and for regulating its excess. In regard to the supply of water and its indications, good pumps of proper construction, with the ordinary gauge-cocks, glass-tubes, and good attendance, constitute the safeguards most to be relied on. A thermometrical instrument might be added to the boiler, without detriment. Water-floats and their fixtures, I consider as objectionable in marine-boilers, and will not be found practically useful. In the present state of the art, new inventions of apparatus do not appear to be required, but only the judicious and proper use of such as we now possess, combined with boilers of *sufficient strength* to resist successfully all the ordinary defects, deteriorations, and exposure, which may arise during their use, from inattention or otherwise.

If high-pressure engines must continue to be used (of which I see not the utility or necessity), the working pressure *should never exceed fifty pounds to the square inch;* and this may be easily effected by increasing the size and stroke of the working cylinders and piston.† The forms of the boilers should be cylindrical, and their diameters from 36 to 42 inches, supported by their centres as well as at their terminations. Flues, if of a size affording but one or two in each boiler, are always dangerous; they displace too much water, and also obstruct the proper cleaning. Flues, however, are not to be dispensed with; but their number should be increased, and their size diminished. An upper tier of four flues, and a lower tier of two (the latter somewhat larger than the former), are not too

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* See Journal of the American Institute, September 1838, p. 646.

† Since the above was written, I have seen the Report of Dr. Lock, on the disastrous explosion of the new high-pressure steamboat Moselle, at Cincinnati, in April, 1838; and I am happy to find that my general conclusions appear to be confirmed by the facts and observations which have been adduced by this distinguished friend of science: although there are some few of his positions that perhaps cannot receive the sanction of practical engineers. After an able examination of the facts in this case, Dr. Locke comes to the conclusion, that "with probably a sufficient supply of water to protect her flues, and the safety-valve overloaded, the Moselle burst her boilers by a pressure greater than the strength of her boiler iron, undiminished by heat, could sustain."—*Report, &c.*, p. 52, Cin. 1838.

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many for boilers of 42 inches diameter, or of 44 to 48 inches, if low pressure. These smaller flues, if properly arranged, will greatly facilitate the cleaning, and displace but little water; but their length should not usually exceed ten or twelve feet, as they abstract the heat very rapidly, owing to their small size. They will be better if made perfectly smooth on their inner surface, from a single long sheet of iron, lighter than the shell; and are not often liable to leaks or accidents. The outer shell should never be less in thickness than a full quarter of an inch; and a thickness much exceeding this, it is well known, cannot be used with advantage.

In condensing engines, which work expansively, called low pressure, when working with ordinary speed, the pressure of steam should usually range between one and one a half atmospheres above the boiling point. But on emergencies, the pressure may be increased to two atmospheres. *The boilers should have a range of strength falling but little short of those used for high pressure.* They may be constructed of the common wagon-top form, provided that they are properly braced in their flat sides and arches, and have as many as four or six flue-arches for a boiler of eight or ten feet in width. The returning flues should be cylindrical, and of smaller diameter. The water-sides, water-bottoms, bridge-walls, and all other flat surfaces, should, however, be brace-bolted at intervals of six inches; and the arches, shell, and all other portions, secured in a proportionate manner. If a *steam-chimney* is used, even of the circular form, it should be brace-bolted at smaller intervals than any part of the flat surfaces which are covered by water.

Flat water-sides, ends, and bridge-walls, if rightly constructed, may be adoped with great safety and advantage for high-pressure boilers; but the brace-bolts, in these cases, should be at intervals of one to *five inches*. Good brace-bolts of iron, eleven-sixteenths of an inch in diameter, with light sockets, if the same are well and securely driven, will be sufficient.* These water-sides and ends may be so worked on to the cylindrical portions of the boilers as to form one structure, in which a greater circulation may be provided for, and much of the ordinary sediment be prevented from becoming injurious to the boilers. The same principle of construction may also be adopted for low pressure, as has been done in the boiler which has been used in the steamboat Oliver Ellsworth since 1833; but in such case the cylindrical portions or shells may have a diameter of 44 to 48 inches. The boiler-heads should in all cases be of wrought or rolled iron, of extra thickness and securely braced. An addition, in the form of a truncated cone, may be affixed on the top of each cylindrical portion, in order to increase the steam-room and to communicate with the steam-pipe. The top or head of this appendage may be of cast iron, and calculated to receive the man-hole plate and safety-valve.

For low-pressure boilers, the general form of the locomotive boilers, with numerous small flues, has been successfully adopted. For these boilers, if the requisite provisions for strength be carefully attended to, copper may sometimes be admissible; but in this case, the securities should greatly exceed those of an iron boiler of the same general construction.

In specifying these methods of construction, no new or untried plans

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* These brace-bolts are better to be screwed in, without sockets; and afterward riveted, with or without an outside nut or screw-head.

have been suggested; but only those of known advantage and efficiency, such as have fallen within my own observation or practice.

In the use of muddy or salt water, the blow-off cock should be frequently and freely used. Condensation in a multiplicity of pipes, and the use of the distilled water thus obtained, on the plan which Mr. Hall has introduced in England, will probably be found attended with more advantages than inconvenience, particularly in sea voyages.

Boilers should at all times be kept free from sediment, and the riveted joints, especially those which are exposed to the fire, should be made subject to frequent and careful examinations, and the smallest appearance of leakage in these should receive immediate attention.

But, with all these precautions, it is *possible* that accidents of a serious character may sometimes happen to steamboats, as well as to ships, bridges, carriages, and other structures, in which much care and attention have been given to the best means of security.

Should the facts, however, which have fallen within my knowledge or observation, as set forth in this communication, or the conclusions derived therefrom, contribute, in any degree, to the correction of prevailing errors of theory or opinion, and cause a greater reliance to be placed upon the most available of all remedies, namely, *a proper increase in the strength of boilers, together with the abandonment of the higher degrees of pressure*, and thus secure a greater degree of safety to the travelling public, my object in thus responding to the call of Congress will be happily attained.

I am, sir, very respectfully, your obedient servant,

WILLIAM C. REDFIELD.

Hon. LEVI WOODBURY,
Secretary of the Treasury